ENVIRONMENTAL STRATEGIES

Edited by :
Dr. R.M. Lodha
Associate Professor & Head
Department of Geography
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The idea of editing this book was initiated in the early 1993 which was further strengthened during my academic visit to U.S.A. from October 1993 to February, 1994; where environmental cleaning is of prime importance, enjoying top priority at each and every level.

It is well known fact that it is very difficult for single author to develop a fullproof strategy, more so in case of Environmental Pollution because of varieties and large number of industrial plants and much complex environmental problems posed by them. Moreover, the Environment itself is an interdisciplinary based subject. However, the concerted efforts have been made to pr vide the suitable strategies to check and rather to avert the pollution.

My heartfelt thanks are due to all the eminent authors belonging to different disciplines, who have extended their whole-hearted co-operation by contributing their intensive research based valuable articles to develop a network of environmental strategies.

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3rd August, 1994

Udaipur — *R.M. Lodha*

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CONTENTS

ENVIRONMENTAL STRATEGIES AND THEIR PROLEGOMENA

Dr. R.M. Lodha

Since the evolution of human life on the earth, the interaction between man and environment is one of the essential aspects of human development. However, the tremendous change brought about by man at massive scale and the accelerating pace, as a result of technological advancements which have put unprecedented pressure on tha fragile environment surrounding his own region Exploding population, industrial and agricultural revolutions along with the intensifying impact of universal urbanisation process have also accountad for undesirable effects on man's physical environment.

The economic activity located in any region has been viewed only in economic and social context so far as economic davelopment is concerned but tha improvement of environmental qualities are considered secondary which have lead towards the environmental detenoration. It is not enough to understand the existing complex relationship among various entities of environment but concerted and planned efforts have to be made to manage the resources and to create a better relationship with nature by locating economic activities in a planned way and setting certain norms of resource exploitation.

Environmental scientists have profound concern for global misuse and abuse of nature in the name of development and progress, relates not only to the present rate of air, water and soil pollutions but to the over all dangers to the biological rhythm everywhere on account of the unabated process of widespread universal degradation of the environment and the imminent threat that looms large on the entire humanity. The council of environmental quality sounded a warning to developing countnes, stating that if the present trend continues, the world at the end of the 20th century will be much more crowded and polluted, less stable ecologically and more vulnerable to disruption than the world we live in now; has almost been proved

Through the burning of fossil fuel during the last one hundred years, more than 240 billion tonnes of oxygen was exhausted and

about 360 billion tonnes of carbon dioxide was discharged into the atmosphere. This has led to a higher carbon dioxide content and oxygen deficiency in the atmosphere. This disturbance in the ozone sphere is the serious threat to the mankind. The basic reason for the ecological crisis is man's greed, lead into different attitude towards nature and his adaptability to the deteriorating environment. The degradation of the environment all over the world has become a matter of great concern to everyone. Although much damage has already been done and the process of degeneration is continuing unabated to some extent, *fortunately an awareness has also been grown everywhere about the imminent threat that looms large because of reckless exploitation of the resources A positive approach towards understanding the environment and initiating action towards its improvement against undesirable human interference and its preservation by planned development are being adopted by most of the* countries.

Now it is tha primary duty of all concerned to sava this 'spaceship' aarth while planning environmental strategies. Strategies may be for exploitation of resources, especially forest, mineral, petroleum and even water, use of energy, disposal of industrial wastes, location and siting of industries, usa of pesticides, insecticides, fertilizer and due to thesa tha outcome in the form of acute air, water and soil pollutions and their extent and intensity alongwith impacts. The pollution measuring kits and methods etc., ozone layer and changes in climatic conditions, their impact on the land and water, disturbing the whole bio sphere need special attention, legal strategies are now of particular relevance regarding preservation and conservation of the resources The polluters can be pricked only through legal actions. Strategies for sustainable industrialization, i e industrial development with minimum destruction, replacement of coal by natural gas, by solar, or wind energy, compulsory recycling of essential materials of mass consumption, ecological management of industrial wastes are important. Gandhian ecological and sustainable industrialization, low waste or no waste, sustainable industrial technology are among a few strategies Cultural and behavioural changes in demand, sustainable forestry through people's participation are equally important strategies.

To work out the strategies itself is a very big task However, the concerted efforts have been made to bring out certain strategies for the environmental protection. These are the case studies conducted in

the field, provide an eye witness of man-environment relationship A few of the strategies are as under :

In the first chapter Dr. Rajiv K. Sinha deals with the global environmental protection. 'A strategy' formed at the Rio Earth Summit in 1992. Besides reviewing the Summit of 1972 held at Stockholm, the new strategies were put to meet the intensifying menace of pollution. It was a great success and the master mind of this summit, Dr. Maurice F. Strong became a world known figure (India has recently awarded him Nehru Prize of world peace May, 1994). 3000 delegates of 150 countries discussed the basis of sustainable development, arresting further degradation of environment along with the repairing the damage already done. Thus about 14 major issues were selected for discussion. In this summit many issues like 'Agenda 21 Global partners In Progress, 'Earth Charter', "Our Common Home" "Poverty and Pollution" emerged. It is supposed to be a grand success. Among the achievements the Treaty for Reduction of Green House Gas Emission, conservation of Forest and Bio-Diversity, the creation of the Fund for "cleaning up" of the polluted Environment and Repair of the Dameged Earth, Technology Transfer, etc. are most important.

This summit firmly laid the foundation stone for a better world of tomorrow. Despite some disappointments, the achievements were big. Road to Rio was begun 22 years ago at stockholm has marked ahead with more vigour and enthusiasm towards a greener and safer world, *where there must neither be pollution nor poverty. Preservation of both* the environments, the physical as well as social is vital for the existence of mankind on earth.

Shri Bajrang Lal jaithu discussing the heating up of earth writes that after the consumption of carbon-dioxide by the plants a large part still remains In the atmosphere. The unmindful activity of cutting the trees is disturbing the equilibrium while raising the concentration of carbon-dioxide. This gas being a green house effect gas, absorbs the heat reradiated by the earth while preventing the radiation going into the space. It affects the both, atmosphere as well as hydro sphere. The rise in the temperature of the oceans has been considered a good basis for the temperature measurement. On the basis of velocity of sound, the temperature trend is measured as with the increase in the temperature, the velocity of sound also will increase. It is measured with the help of a transmitter. In case of the increase in the *temperature, time taken by the signals will be decreased at the rate of* a quarter of second in one year.

Dr. D.C. Sharma describes that whole matter on the earth is made up of atoms of about 103 elements. He mentions that about 26 elements are considered essential for life but many other elements are non-essential for life and are toxic to the life. For life, both are considered as two sides of one coin. In this article Dr. Sharma has discussed the effect of trace elements like fluorine, selenium, lead and cadmium. According to him the pollution of environment from fluorine and selenium is caused by nature itself, the pollution from lead and cadmium is man made. Dr. Sharma comments that environmental pollution by toxic metals is much more serious and it poses much more problem than the organic substances like pesticides, as most organic substances are degradable by natural processes, while no metal is degradable. The metallic and elemental pollutants are going to stay in the environment for a long time. Therefore, every effect must be made to prevent the accumulation and contamination of toxic metals and elements in the environment by the man made techniques.

Dr. (Mrs) Rekha Thakre and Shri A.L. Agrawal, Scientists, Neeri Nagpur while discussing land management strategies in the areas of thermal power plants of India remark that the production of energy by thermal plants ranks at the top of the list of such pollution intensive industries, polluting air, water biota etc Out of the total power production (TPPs) in India more than 60 per cent is generated through TPPs using coal producing on an average over 26.2 million tonnes of solid combustion by products each year and it will continue for a few more years. The authors warn that the solid combustion products are voluminous and pose the threat to environment, it not managed properly They suggest that there has to be stringent management strategies lest the land, the most precious and limited resource of the ecosystem will be contaminated to a point of no return. The coal ash affect air quality, soils and terrestrial vegetation, aquatic biotoxicity, ground water, surface waters, etc., very badly. It brings the changes in physical properties of soil, specially reduction in bulk density, reduction in modulus of rupture, effects on hydraulic conductivity, susceptibility to wind and water erosion reduction. Among the natural mitigation strategies, soil buffering capacity, organic matter amendment on polluted sites, low soil permeability, abatement of air pollution by green belt are important Among the engineered control strategies important are lining the ash ponds, leachate collection systems etc

Mr. Ashok Kumar Mahbubani in his article "Control of SO_2 Emissions from Fossil Fuel-Fired Steam Electric Generated Plants"

analyses that among the gaseous air pollutants, the sulfur dioxide have historically major attention because of their common occurrence and are known for harmful effects at high concentrations Mr. Mahbubani discusses the harmful effects of SO_2 and Air Quality Standards, *Methods of SO_2 Emission Control, Use of low sulfur fuels*, dilution by tall stacks and reduction of concentration level of SO_2 in the stack gas by subsequent treatment in detail He also discusses SO_2 removal processes. Finally he concludes that it is necessary to take all possible precautions for minimizing the release of SO_2 because of its severe harmful effects. It becomes more harmful in densely populated areas like urban centres While suggesting the strategy, he remarks that tail gas treatment processes can be adopted depending on the local availability of the absorbent.

Dr. (Mrs) Neeta Chaturvedi and Ajay K. Awasthi stress in their article entitled : "Environmental Health, Impact Profile of Lime Kilns at Malhar" thet the Lime kilns have serious impact on locel environment. In the present study an attempt has been made to highlight various heelth impacts caused due to lime kiln activity et meihar (M.P.). The study reveals that the overall health Impacts of lime kiln et Maihar are nagetiva (-460 974). The calculated impact value (-460.974) when placed in e hypothetical impact assessment scale reveeled that the negativity of impacts ranges between 60% to 70%, meening thereby that the magnitude of health impacts due to lime kilns are very high and adverse.

Dr. S.K. Agarwal in his article entitled : "Principles and Problems in Water Resource Management" comments that water is essential not only for the substance of human life and activities but for the 'quality of life' as well. it is rather the essence of life on earth and totally dominates the chemical composition of all the organisms. Dr. Agarwal empathetically stresses that the discharge of effluent into surface water has polluted the water to a great extent more so when polluted water flows underground, mixing with the water channels, thus aggravating the water problem both of quality and quantity. Dr Agarwal while planning the proper strategy, advocates that an adequate utilization of water resources and desirable control of the use of water are possible with proper utilization of all available means like legal, institutional, technical, economic personal and moral

Dr. R.M Lodha, the editor of this book presents and intensive research based on Inter-disciplinary approach This is the study of Udaipur Micro Region having 360 large and medium scale and more

than 3000 small and cottage type of units. The region has occupied national and regional level ranks in few industries. Dr. Lodha reveals that the city dwellers get their more than 70 per cent potable water supply from highly polluted lakes Most severe is the problem of water pollution in the region due to siting the industrial plants unmindfully.

To avert the water pollution in the region Dr. Lodha has divided the polluted area into following sub-divisions - Areas into which industrial locations should be (b) strictly prohibited, (b) permitted with entipollution measures and (c) permitted unobstructed. He has also suggested certain precautionary measures (i) establishment of non-polluting industries and shifting and even removal of certain existing industrial units; (ii) proper selection of sites of the plants; (iii) awareness. If all the measures fail, Dr. Lodha has suggested antipollution natural laws which do not cost anything, except to apply common sense. These are while locating any factory (i) avoid the hill habitation, (ii) avoid disposal of effluent into the natural flow of water; (iii) avoid porous rocks end rock structure, where it would cause infiltrated polluted water from moving downward to contaminate wells of the region.

Scientist Mr. B.S Sokhi in his articles "Environmental Impacts of Channelizetion of River Yamuna in Delhi" writes that river channelization is one of the oldest methods to create an area of controlled environment. It has increased in the wake of increasing need of land for population, agriculture, industry, etc. In the first part of the article, Scientist Sokhi discusses theoretical aspects of river channelization, its purpose, impact on backside ecology etc. In the case study of river Yamuna, he analyses its fauna and flora in detail and warns that channelization of river and development along it would disturb the natural conditions like habitats, food chain, etc. After channelization and subsequent urban development the human activities will increase, which will be counter productive for the existence of fauna, especially for migrating birds and flora

Mr Sokhi further recommends that such programme must be planned on the basis of interdisciplinary approach. The proposed modifications be incorporated as the work progress rather than introducing later as remedial measures. It is highly essential to monitor the impacts of channelization schemes continuously.

Dr. R.K. Shrivastava in his article "The Biodiversity" writes that biological diversity is the total variety of life on the earth, quoting U.S. Institutes Dr. Shrivastava discloses the fact that about 50,000 invertebrate species per year (140 each day) are condemned to

extinction by the destruction of their tropical rain forest habitat. Deforestation condemns at least one species of bird mammal or plant to extinction daily. According to him extinction and evolution of species have gone side by side. But the scientists are worried about the present wave of extinctions for which human being is more responsible. It is also because of escalating demand for resources leading to serious ecodegradation and not due to natural action. Almost all types of habitats found in the world are found in India. He stresses that micro-organisms' plants and animals are the result of evolution over million of years and being biologically active entities; they are extremely vulnerable and once they are lost, they can't be replaced at any cost. The world's conservation strategy advocates maintenance of essential ecological processes and life support system on which human survival and development depend We should follow the idea that conservation and development are the two sides of the same coin. Finally he suggests that the protection of biodiversity has to be considered a basic requirement of subtainability passing on to future generations, a word of undiminished options and a fundamental moral responsibility as traveller on the only planet known lo support life.

Prof. S.S. Merh discussing "Geoenvironmental Diversity of Gujarat" writes that it provides an interesting terrain diversity, and is perhaps the only state in the country within which the various geoenvironments, i e. marine, fluvial and aeolian are present. Prof. Merh suggests that a proper evaluation of the various geoenvironmental parameters is most vital from the point of view of a successful management of terrain development activity. Our past experience has shown that various developmental projects be they dams, canals tubewells, roads, harbours or mining or oil exploitation activities, all these if not properly planned; cause immense and sometimes irrepairable damage to the quality of life, thereby defeating the very purpose for which the developmental activities are taken up. What is now urgently needed is a concerted and integrated effort by eco-scientists to investigate thoroughly all the geomorphic characteristics, environmental factors and workout a developmental strategy for Gujarat so that maximum benefit is derived out of its terrain with minimum creation of geoenvironmental imbalances

Madan Mohan in his article "Developmental Strategy through ecology" stresses that let us save ecology from development. At the sometime, let us save development also from ecology. He discloses

that in the middle of this century, it was realized that both the structure and the functioning of the relationships are important in the understanding of ecology. He stresses that experience shows that development which takes place at the cost of environment can only be a short term development. Madan Mohan in his concluding remarks puts forward certain strategies and writes that wherever the symbiotic relationship between man and environment is found desirable called "ecological imbalance" and whenever such environmental factors cannot support human needs and aspirations because of exterior deterioration and over-exploitation of such environment it is called "ecological imbalance". He suggests two strategies of ecology and development Firstly, the strategy of development at all cost and secondly, the strategy of rejecting development in the name of ecology. Further, he suggests that the laws of nature not only impose constraints on but also point to the direction of optimal development Ecology is never opposed to development but it pleads that any development plan be examined for its environmental impact before implementation The ecology also pleads for preservation of unique ecosystem for the future generations as human being can never reproduce such ecosystem.

Dr. R.B. Singh in his article "Environmental Monitoring Developmental Styles and Research Strategy in Indian Desert Region" writes that ecological degredation is the major critical issue in the desert land as it causes human disaster and is considered as human problem This article assesses landscape degradation for future potential risk of such degradation. Priority has been given in monitoring renewable resources. It is anticipated that such assessment will form the base against which future changes can be measured. He mentions that there are two groups of indicators to be monitored : The physical and socio-economic. Dr. Singh writes that desert encroachment is a serious problem where overgrazing is expanding, reducing the grazing land. Desertification is increasing due to prevailing draught conditions Expanding dunes are grabing the fertile land. Increasing mining activity is enhancing the desertification process

The Indira Gandhi canal command area of this desert proves that if water for irrigation is made available, the land can be agriculturally prosperous To improve the ecological balance afforestation work has been undertaken. Sandunes have been stabilized. Programmes combating desertification include various developmental schemes a different levels, the Desert National Park Scheme (DNP) for the

conservation of biodiversity. Dr. Singh has urged for the effective resourca management strategy specially for better corpping pattem, irrigation system, animal husbandry, forestry, horticulture, establishment of industries etc. Dr. Singh has suggested 19 research strategles for the sustainable development of the region.

Mr. Rathindranath Peuf and Prof. C.R. Pathak in their article entitled "Environmental Planning Problems in Calcutta : A Development Strategy" write that in the third world countries like India population growth is highly concentrated in the metropolitan cities. High rate of natural growth along with uncontrolled population immigration which is mainly because of deteriorating economic environment hava a strong relation with deplorable city environment. Calcutta which was the biggest metropolis in India in 1981 has become really uninhabitable now-a-days.

Prof. S.D. Sabnis in his article entitled "Environmental Perspective of Narmada Project as Perceived by a Biologist" remarks that the project which has come to the prasent stage after a tribunal award is still running through rough weather on various counts. He furthar suggasts that if we accept for better and a mora purposeful human existence, environment and development must go hand in hand, it is necessery that avery major human intervention in the natural process ba assessad in terms of its environmental impact. Large dams are such interferences which turn a free-flowing rivar system into a multilevel lake mode with obvious ecoenvironmental impacts involving all physical and biological parameters. Gujarat has considerable length of desert boundary specially in its north and for a short distance on western boundary. It will be 160 m high at Navgam and will lead to the formation of a large man made lake 215 km. long with an average width of 2 km. Submerging about 220 villages having 66,000 people. It will provide irrigation to about 18 lakhs ha., having discharge capacity of 40,000 cusses water and generating 1400 MW of hydroelectricity.

Out of an intensive survey ecosystem classification into 7 ecogrades has been proposed for the state. All the different strategies are being worked out for overall development. Finally Prof. Sabnis remarks that unplanned development can bring about destruction sooner or later but planned development should mean a profitable, prosperous and peaceful co-existence with nature.

Mr. M.S. Sokhi, Mr. P.S. Bedi and Mr. N.D. Sharma in their joint article entitled. "Physical Environmental Study of Residential Area of Ujjain City through Aerial Remote Sensing, mention that residential

environment as a part of 'Physical Environment' has been taken up as a specific study of Ujjain City of M.P. In this study the authors remark that aerial remote sensing played an Important role. This technique has proved to be very useful and was purpose oriented with its time and cost effectiveness in identification and delineation of physical environmental parameters. The area of study has been divided into 4 sub-areas. The Interpretation reveals that the cumulative effect of environment Is highest in sample area I, followed by second highest In area IV, low In area III and lowest In area II.

Shri Madan Mohan in his article entitled "Process of Development and Ecological Habitat of Tribes In India" writes that the tribal population of India is by and large living in remote areas which are comprehensively backward in terms of social and economic development on one hand and on the other hand tribal territories are usually rich In natural resources, particularly in minerals and forests which have been exposed to the nation for exploiting the resources, disturbing the forest ecosystem; thereby affecting the tribal habitat adversely. The have been ignorant of modern institution and changing environment leaving them to undeveloped state. He remarks that a lot of effort has been made for their development through financial assistance from central and state governments etc. but the situation of tribals have not been Improved much. The tribal live In a highly precarious physical conditions and they have to struggle a lot with the nature even for their necessary necessities. It needs a special planning for their development

Geetha Susan Philip and Sathyajith Mathew In their article "Solar Energy for Cooking: A Strategy" comments that cooking accounts for the major those of energy consumption in developing countries. At present we are depending mostly on coal, gas, fire-wood and cow-dung to meet our cooking needs. With the fast increase in population the need of fuel is increasing speedily on the other hand, fossil fuels are running out Above all these aspects the fuels are posing an acute problem of environmental problem and that too of air pollution The use of firewood for cooking has reduced forests considerably, thereby creating severe ecological problems In the wake of this situation only renewable energy source that too specially solar energy can save the world from environmental catastrophe. In this regard authors suggest the harnessing of solar energy and suggest solar ovens, solar baskets, etc. to use in cooking. To encourage this, long terms loans and tax benefits be provided, the

authors suggest. Sathy Ajit Methew and Geetha Susan Philip in another article entitled "Energy From Wind - An Overview" comment that taping energy from today conventional sources has resulted in severe environmental ill effects. The energy generated from the non-renewable resources is highly costly on one hand, such resources once consumed cannot be replaced on the other hand. All such factors force the man kind to turn his attention to new and renewable sources of energy. Wind as an alternate energy has a bright future, he remarks It can also be stressed that wind is environmentally friendly ingredient of the nature. Even power from wind was extracted as early as 400 B.C. Wind power production has its own limitation, the authors remark, specially it is comparatively low power density needing large machines with high expenditure. More so is the case with the establishment of industries in low velocity regions.

To encourage the wind energy, the Government has announced several promotional incentives like subsidies, duty free import of specific spare parts, tax benefits, etc. The authors remark that 43 MW eggregate capacity has been established in tha country. The authors seem not be happy with the state of development of this energy end remak thet inspite of the enoromous energy potential and governmental Incentives, most of our wind energy projects are at the demonstration stage.

Prof. K.C. Sahu in his article "Technology for Environmental Protection" defining environment writes that it is a sum total of tha physical and chemical factors of air, water, soil, often knnown as biosphere. He remarks that the environment in ell sectors is trying to tell us that certain stresses ere becoming excessive around centres of large technological ventures. While suggesting solutions, he remarks that for a solution for environmental protection end conservation in a natural ecosystem whether everything effects everything else directly or indirectly, requires a "Whollistic Approach" or system epproach. He has further suggested 3H to protect the degradation of the environment, i e. technology of head, heart and hand and he named it as "Technology with a human face". Further, the author has emphasized that with progress and advancement and for an improved quality of life, challenge to environmental degradation and consequent pollution can be met by the measures like curetive, preventive and adoptive or symbiotic living

Dr. Anil Shukla in his article entitled "A critical Appraisal on Environment Legislation" remarks that the issue of deterioration of the

environment and the exhaustion of tha planet resources was raised by the highly industrialized countries first of all. In 1972 for the first time, U.N.O. Conference on the human environment at Stockholm proclaimed that the protection and improvement of the environment for present and future generations is a pressing need of mankind. The author remarks that in India even before independence as many as 31 acts were introduced for the protection of environment. Seven acts were paved between 1950 and 1983 related with animals, birds, forest, soil, water, noise, etc. The author remarks that India is one of the very few countries in the world which has provided for constitutional safeguards for the protection of environment. The new environment Act 1986 has been considered a mile stone for the protection of environment by the author, as it is a very powerful Act providing legislative support for the safety of inside as well as outside of the factory. This Act provides a special provision to fix the liability for the offences. Looking towards certain weakness of the Indian Environment Acts author has enlisted 14 suggestions for the effective implementation of the existing environmental laws to curb the environmental pollution effectively.

In the article entitled: "Accessibility of Environmental Laws: An Indian Experience", Dr. Satish Shasth remarks that the Stockholm Conference (1972) was a powerful force in arousing public awareness and understanding of fragility of the environment". Prime Minister of India, late Mrs. Indira Gandhi impressed the participants by her message of 'save the mother earth'. Dr. Shastri refers some of the important laws relating to environment, specially Environment Protection Act, 1986, 5 each laws relating to Water Pollution, Air Pollution, Wild Life and forestry, 4 laws relating pesticides, 3 relating to protection of national monuments and 5 general laws. He further mentions that there are more than 250 enactments relating to environment. In the light of Indian experience he has examined accessibility of these laws by discussing socio-economic liability of the laws vis-a-vis population, poverty and pollution. He has also highlighted the reasons as to why these laws are not popularly acceptable. He discloses the complexity of formulated laws, procedure of implementation, non-suitability to our socio-economic conditions age old base of laws, slow litigation process, multiplicity of the authorities etc. Lastly, he has proposed certain suggestions for the effective implementation and recommended that law should not act as governor but as a helper to put the things in right perspective. Law should work as an instrument of social order so "the spring may not be

silent, the sun may not be shy to shine in smog, the woods may be lively, green and dark, Gandhi may live a hundred years more and air, water and atmosphere may ba pure and fresh and tull ot health".

Dr. Satish Shastri in his another article entitled. "Law Relating to Hazardous Waste Management - An Indian Experience" remarks that industries, though contribute to the development and progress ot a nation but their wastes and toxic effluent discharged freely in the air, water and on land are doing irreversible irrepairable damaga to mankind. Similarly, unbridled exploitation of renewable and non-renewabla natural resources without carrying tor the waste and scree has caused ecological imbalances and environmental pollution problems. He analyses number of acts and explains the Environment Protection Act 1986. The Hazardous Wastes Rules, 1989 and manufacture, storage and import ot hazardous chemicals Rules 1989 In greater detail. Under hazardous chemicals Rules 1989 any Industry shall ba raquired to fulfil a tew conditions befora it starts working or In cesa of an existing industry within e period of ninety days of coming into operetion. Notification of Sites, Sefety Report, preparation ot On-Site Emergency Plan by the occupier, Preparation of off-site emergency plans, Information to the persons liable to be affected, preparing sefety data sheet, etc. Besides, he explains penalty for contravantion of tha provisions ot the Act whila sighting the examples of 'The Water (Prevention and Control ot Pollution) Act 1974'. The Water Cess Act 1977'. The Factories Act 1948, 'Tha Public Liability Insuranca Act 1991', etc. He remarks that the role of law in managing the hazardous wastes and toxic substances is very important. He has put forward number of suggestions to improve upon tha present day situation and to implement the laws through 3 Es efficaciously, effectively and efficiently.

Dr. S.K. Aggrawal and Shri N.J. Singh in their article entitled. "Environmental Audit: An Inevitabla Strategy" discuss that the environmental audit is rather a controversial issua suffering from certain levels ot ambiguity with the management ot Industries. Consultants are also not clear about the depth to which an audit should be carried out. Too much depth ot study could put-off the Industry, whila too shallow a study may not be acceptable to the regulatory authorities. Probably, a pragmatic approach will have to be adopted, without sacrificing the essentials of the study. Dr. Agarwal and Shri Singh In this article analyse the regional carrying capacity, environmental impact assessment, components of environmental

audit, audit procedure, pre-audit activities, activities at the site, post-audit activities. The benefits of environmental audit include minimisation of waste generation and so also the cost of effluent emission treatment by identification of residues/rejects which can be effectively recycled/reused even with the existing technology of operation provided the industries to adopt optimal use of resources through self discipline of environmental audit.

Dr. R.M. Lodha in his article entitled "Environmental Awareness: A strategy" suggests a five fold strategy for cultivating environmental awareness. According to him while establishing the Environmental Clubs, imparting Environmental Education at all levels, framing and practicing Laws and establishing the School of Environmental Sciences, Environment Improvement Trust an overall awareness can be induced in the society. While sighting the example of the Supreme Court order, he suggests awareness must be spreaded through mass media and effort must be made to produce films and video cassettes on various topics in the subject of Ecology, Pollution, Environmental degradation, Pollution, control technologies, energy options, natural resource conservation, sustainable development, etc. For environmental education he quotes the scheme planned by Prof. K.S. Chalam. Dr. Lodha himself has suggested the establishment of the School of Environmental Sciences. He has also worked out Environment course based on UGC Guidelines. In the last he has suggested to establish 'The Environment Improvement Trusts' for fullfledged cultivation of environmental awareness.

Dr. Rajiv K. Sinha suggests the strategies in his article entitled "Strategies for Sustainable Industrialization". At the outset he comments that industrialization is a "necessary evil" and the modern human civilization also cannot do without it. Replacement of coal by Natural Gas as a source of Energy for Major Industries, Ecological Management of Industrial Wastes, Compulsory Recycling of Essential materials of mass consumption, Low waste or No Waste, Sustainable Technologies are the applicable strategies to improve the environment. To maintain the quality of environment, he stresses the idea of Gandhian Ideology and Cultural and Behavioural Changes in the Demand.

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GLOBAL ENVIRONMENTAL PROTECTION : A strategy

Rajiv K. Sinha

The seeds for the historic "Earth Summit" - The United Nation Conference on Human Environment and Development (UNCED) held at Rio de Janerio, Brazil (June 2 to 12, 1992) was sown 20 years ago at Stockholm, the capital of Sweden where first "Eco-Political" meet of heads of nations on human environment took place. vigorous preperations for this historic meet of the heads of netions were being made for the last two years and several pre-Rio conferences to chalk out the agenda for the earth Summit were held at Nairobi (Kenya), Kuela Lumpur (Malaysia) and Beijing (China).

Dr. Maurice F. Strong was Secretary General of the Rio conference and a guiding force behind all eco-political deliberations which occurred in the meeting. The action plan of the conference covered very aspect of environmental problem from global warming to ozone depletion; loss of tropical forest and biodiversity, to population bomb; funds for global environmental clean up and transfer of technology. The Earth Summit was also an outcome of the famous "Brundtland Commission Report" on environment which initiated the debate on the need to translate the concept of sustainable development into action.

In December 1989, the United Nations General Assembly responding to the report of Brundtland Commission decided to call for a world conference to discuss the basis of sustainable development, arrest further degradation of environment, and repair the damage already done. The following environmental issues were selected for discussion among the world political leaders and the heads of the states at Rio :

1. Protection of the atmosphere from global warming ozone depletion and transboundary air pollution.

2. Protection of land resources (combating deforestation, soil loss, desertification and drought).
3. Conservation of biological diversity.
4. Protection of ocean, seas and the coastal areas and the rational use and development of their resources.
6. Environmentally sound management of biotechnology and hazardous wastes (including toxic chemicals).
7. Prevention of illegal traffic in toxic products and wastes
8. Improvement in the quality of life and human health.
9. Improvement in living and working conditions of the poor by eradicating poverty and stopping environmental degradation.
10 Control of unabated population growth in the developing countries through adequate measures.
11. Change of lifestyle and giving up of the culture of over-consumerism by the people in the developed countries.
12. Creation of a global environmental protection fund through mandatory contribution of all nations.
13. Transfer of ecologically benign technology from the developed nations to the developing nations at a cheaper rate.
14. Search for environmentally safer and cheaper energy sources for the future.

The heads of more than 150 nations and over 30,000 delegates from all over the world which included reputed environmentalists, scientists, human ecologists, educationists, philanthropists, industrialists, leaders of business and trade unions, religious, cultural and political leaders, men and women, indigenous people and the NGOs participated in the 12-day long conference. Over 6 lakh square metres of land, including small lakes was transformed in just 45 days to host such a big audience of the participants.

An agenda for action called 'Agenda 21' incorporating the work programme of the International Community as "Global Partners in Progress" for the period beyond 1992 and unto the 21st Century was prepared by the heads of the nations and released a "Earth Charter" or "Rio Declaration". The Rio Declaration on the principles of general right and obligations on environmental protection initiated by heads of

nations stated, "Recognizing the integral and inter-dependent nature of mother earth 'our common home', we proclaim thet :

1. *Human beings are at the centre of concerns for sustainable* development. They are entitled to a health and productive life in harmony with nature.
2. States have in accordance with the charter of the United Nations and the principles of Internetional law, the sovereign right to exploit their own resources persuant to their own environmental policies and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other states or ereas beyond the limits of national jurisdiction.
3. The right to development must be fulfilled so as to equitably meet development and environmental needs of present and future generations.
4. In order to achieve sustainable development environmental protection shall constitute an integral part of the development process and cannot be considered in isoletion.
5. All states and all people shall cooperete in the essential tesk of eradicating poverty as en indispenseble requirement for sustainable development.
6. The special situation end needs of developing countries perticularly the leest developed end those most environmentally vulnerable, shall be given special priority, international actions in the field of environmental and development should also address the Interest and needs of the countries.
7. States shall cooperate In spirit of global pertnership to conserve, protect and restore the health and integrity of the earth ecosystems. In view of the different contributions to the global environmentat degredation, the states have common but differentiated responsibilities. The developed countries ecknowledge the responsibility that they bear in the international pursuit of sustainable development in view of the pressure their societies place on the global environmental and of the technologies and financial resources they command.
8. To achieve sustainable development and a higher quality of life for all people, states should reduce and eliminate unsustainable patterns of the production and consumption and promote appropriate demographic policies.

9. States should cooperate to strengthen indigenous capacity building for sustainable development by improving scientific understanding through exchange of scientific and technological knowledge, and by enhancing development, adaptation, diffusion and transfer of technologies, including new and innovative technologies.

10. Environmental issues are best handled with the participation of all concerned citizens, at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities and the opportunity to participate in design making process. States shall facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided.

11. States shall enact effective environmental legislation. Environmental standards, management objectives and priorities, should reflect the environmental and developmental context to which they apply. Standards applied by some countries may be inappropriate and unwarranted economic and social cost to other countries, in particular developing countries.

12. States should cooperative to promote a supportive end open international economic system that would lead economic growth and sustainable development in all countries, to better address the problems of environmental degradation. Trade policy measures for environmental purposes should not constitute a means of arbitrary or unjustifiable discrimination on international trade. Unilateral actions to deal with environmental challenges outside the jurisdiction of the importing country should be avoided. Environmental measures addressing transboundary or global environmental problems should as far as possible, be based on an international consensus.

13 States shall develop national law regarding liability and compensation for adverse effects of environmental damage caused by activities within their jurisdiction or control to areas beyond it.

14. State should effectively cooperate to discourage or prevent the relocation and transfer to other states of any activities and

substances that cause severe environmental degradation or are found to be harmful to human health.

15 In order to protect the environment, the precautionary approach shall be widely applied by states according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific knowledge, certainly shall not be used as a reason for postponing cost-effecting measures to prevent environmental degradation.

16 National authorities should endeavour to promote the Internationalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should in principle, bear the cost of pollution, with due regard to the public interest ahd without distorting international trade and investment.

17. Environmental Impact assessment, as a national Instrument, shall be undertaken for proposed activities that are likely to have significant adverse impact on the environment and are subject to a decision of a competent authority.

18. State shall immediately notify other states of any natural disasters or the emergencies that are likely to produce sudden harmful effects on the environment of those states. Every efforts shell be made by the international community to help states so afflicted

19. States shall provide prior and timely notification and relevant Information to potentially affected states on activities that may have a significant adverse transboundary environmental effect and shall consult with those states at an early stage and in good faith.

20. Women have a vital role in environmental management and development. Their full participation is, therefore, essential to achieve sustainable development.

21. The creativity, Ideals and courage of the youth of the world should be mobilised to forge a global partnership in order to achieve sustainable development and ensure a better future for all.

22. Indigenous people and their communities, and other local communities, have a vital role in environmental management and development because of their knowledge and traditional practices. States should recognize and duly support their identity.

culture and interests and enable their effective participation in the achievement of sustainable development.

The Earth Summit turned into a veritable North-South confrontation on several environmental issues. Serious rifts grew between the developed and the developing nations over the question of who is to be held primarily responsible for damaging the earth and environment and who shall pay for the repair. So wide has the gulf been created that nations have started forming power blocks quite similar to the erstwhile military alliances. Environment has suddenly become a major foreign policy issue of the developed and developing nations which has become divided into two groups on environmental issues.

The former as G-7 nations comprising the North industrialized countries of US, UK, Canada, Germany, France, Japan, Sweden etc and the latter as G-77 nations comprising the South countries which are actively represented on world forum by India, China, Brazil, Pakistan, Philippines, Bangladesh, Indonesia and several Latin American, Asian and African nations.

The two groups of nations G-7 and G-77 have common environmental problems among them. While the environmental problem of the North experiences from "plenty" and "over-consumption" that of South results largely due to"poverty" and "over -population" and "poverty" is the greatest "polluter". This was rightly remarked by late Prime Minister Mrs. Indira Gandhi at the historic Stockholm Conference in 1972. The world leaders and the policy markers of the North nations have to realise that the global environmental issues can no longer be treated as separate from the issues of international debt, trade, unemployment, inequality in consumption of resources and poverty. As long as there is poverty, social inequality and disparity in consumption of resources there can be no sustainable development in the world.

Unfortunately the issue of "poverty" and its close link with "pollution" has not been taken seriously at Rio.

The Issues at Stake: Achievements and Disappointments

Four major issues which cropped up for vigorous debate and discussion among the heads of Government and whose deliberations divided the North and South nations at Rio were:

1. Emission of green house gases and global warming.

2. Protection of the tropical forests of the world and preservation of bio-diversity,
3. Allocation of funds and finances for the cleaning up operations of the environment and repair of the damage done to the Earth, and
4. Transfer of environmentally safer technologies from the developed nations to the developing ones.

The summit did not take up seriously many relevant issue like the *threat of "acid rain" and ozone depletion; safe disposal of toxic* wastes, both chemical and radioactive; human ecological problems arising out of harnessing of nuclear energy; indiscriminate use of chemicals in agriculture; rapid urbanization and industrialization; the *close link of poverty and malnutrition in South nations with population* explosion and pollution; the negative ecological impact of great disparity and inequality in the distribution and consumption of global natural resources; the serious environmental problems arising from the 'over-consumerism" culture of North and above all, the huge expenditure being made and essential waste on " military build-up" by both the North end South nations.

Achievements

1. The Treaty for Reduction of Green House Gas Emission The climate treaty to reduce the green house gases was the biggest achievement of the Earth Summit. Some 150 nations from North and South signed a treaty and pledged to reduce the emission of carbon dioxide and other gases like nitrogen oxide, methane, and chlorofluorocarbon which enhance global warming. The 12 nations' European Community and Japan went further and promised to limit their carbon dioxide emission at 1990 level by the year 2000 A.D. Most nations wanted a 20% cut, but Germany under the stewardship of Chancellor Helmut Kohl declared 25 to 30% reduction by the year 2005.

The South nations were reluctant to any cut in their own carbon emission as it would hinder their economic development. Their argument was that their economic development. Their argument was that their total emission amounted to only 20% whereas the North emits 80 % of the green house gases from their industries automobiles. Whatever may be the argument but this attitude of South nations is not going to help the environment. CO_2 emitted from North or South is going to join the same global atmospheric pool and bring about the green house effect

2. The Treaty for Conservation of forest and Biodiversity The biodiversity treaty for protecting the plant and animal species from the dangers of extinction was yet another big achievement of the Summit. It was signed by 150 nations except the US who was virtually isolated on the issue It is a well known tact that the tropical forests of the South are rich in biodiversity and ara storehousa of uniqua "genes" in the wild state. The industrialized nations of tha North exploit those genes from the wild plants and animals of the tropical forest of South to improve the productive value of their crops and cattle and produce a variety of medicines and chemicals through biotechnological researches. USA bred a new high yielding variety of maize (*Zea diploperennis*) worth million dollars in value with the help of valuabla genes from wild maize species obtained from tropical forest of South. The wild genes also provide ability to adapt against diseases, pollution and environmental hazards. Ona 'gene' from a single 'wild barely' plant of tropical forest protects US $ 160 million annual barely crops from "Yellow Dwarf Virus". US has $ 6 million biotechnology industry and it is afraid that it would have to shara the fruits of researches into biotechnology with ha Third World nations in exchange for the wild genes from their tropical forests. They call it as an "Intellectual Property Rights". But is it not equally unfair and morally unjustified if a developing country from which valuable "genes" of wild seed strains are taken and developed into a high yielding superior crop" and then asked to buy the same Improved seeds of superior crop from tha developed nations at a high cost.

Preservation of biodiversity is closely linked with conservation of forest because deforestation leads to loss of biodiversity. The North nations have cleared their forests long back to boost agricultural production and now want to conserve and make the remaining forest of earth as a "global heritage". They consider the tropical forests of the South not only as a "gene bank" of valuable gene pool for their biotech laboratory but also as a "global pollutant sink" to absorb their entire carbon dioxide emissions. Globalization of their forest is seriously objected to by the South nations. Such moves would impinge on their national sovereignty. for the poor Third World people, forest is their means of livelihood , a source of food, fuel and fodder. Their contention is that the rich North must compensate for conservation of forest, pay for working as natural sink of their emitted carbon dioxide and also share in the profits of the biotechnological achievements This was somehow agreed upon by all nations except the US.

3. The Fund for "Cleaning up" of the Polluted Environment and Repair of the Damaged Earth The question, who shall pay for the cleaning up action of the world's polluted environment and repair of damaged earth has become a major controversial issue and a subject of great debate among the North and South nations. As back as in 1989, India under the stewardship of Late Prime Minister Sri Rajiv Gandhi proposed for a "Planet Protection Fund" at the non-aligned summit at Belgrade in which the member countries were required to contribute 0.1% of their GNP. It was repeated by the present Prime Minister of India Sri Narasimha Rao at the Rio Conference.

India advocated for the imposition of "Environmental Tax" on the developed countries at Rio. ET was also proposed at a meeting of 29 eminent political and business leaders in Tokyo, Japan where Mr. Jimmy carter, former US President was an important participant.

Funds for "environmental regeneration" are not to be treated as 'aid' but are more like 'taxes' on 'over-consumption' of the rich North nations which they do on account of "under-consumption" of the poor South. There is no way the poor South nations can be taxed further for the environmental sins of the rich North. For the rich developed nations environment is a "luxury" to be used and exploited for enjoyment, for us it is a means of our very "survival". They are drawing from the global environment to "maintain" their high lifestyle, whereas we are drawing to simply "sustain" our living. They have used up the life sustaining environment for their development and in turn also damaged it, they must pay for it. Further, because they want us to preserve our forest to work as global " carbon dioxide sink" and "gene bank" they must pay for its conservation and further afforestation. The industrialized North in fact owes a "Carbon Debt" to poor South, nations which they must repay.

The UNCED Agenda 21 estimated $ 625 billion (US) annually for the cost of environmental clean up and repair of the damage done to the earth so far. The south already spends $ 200 billion on such activity, UNCED expected the rich nations to chip the remaining $ 425 billion. The rich nations particularly Germany, Japan, France and UK have given a commitment at Rio to try and keep 0.7 per cent of GDP aside for assistance to the poor nations of South to develop environmentally friendly and clean technologies. Japan further promised to increase its developmental aid from $ 400 million per year to $ 1.4 billion Japan also already has provided huge sums for afforestation in the Aravalli ranges in Rajasthan

Meanwhile to tackle urgent environmental problems like global warming, ozone depletion, deforestation and loss of biodiversity, the North nations have set up the Global Environmental Facility (GEF) with an initial corpus fund of $ 1 billion. The funds would be administered through the World Bank and UNDP. The South nations view GEF with suspicion as 70% of its fund is being routed through the West controlled World Bank and hence would be used as an instrument to bully the poor south nations.

At Rio US offered $ 150 million to protect the world forests. Their offer was overshadowed by Germany which pledged to double its aid to developing nations and offered to "cancel all debts in exchange for environmental protection measures." This was the biggest offer ever made at Rio or at any other international eco-political conference. This showed great concern of Germany to help the human race to save from extinction on earth. The European Economic Community (EEC) proposed to increase aids for environmental projects by $ 5 billion, while Mr. Heimut Kohl (Germany) and John Major (UK) announced for additionel $ 43 billion "Green Aid" for the GEF.

Nevertheless, the financial commitment made by the rich nations (North) are not adequate in view of the seriousness of damaga done by them to earth and "goods and services" they have so long drawn and enjoyed from the very environment. And when there is question of 'survival of mankind' on earth any amount is not much. Prima Minister Gro Harlem Brundtland of Norway, who headed the famous "Brundtland commission" on Global Environment and gave the blue-print of the strategies of sustainable development for the world accepted before dozens of Presidents, Prime Ministers and Kings assembled at Rio that the "Eco-fund" created for cleaning the environmental mess was too inadequate. She remarked "We are disappointed by the lack of adequate financial commitments made by the rich nations". Her view was shared by Mr. Maurice Strong, the UNCED Secretary General.

4. Technology Transfer Transfer of ecologically benign and environmentally safer technologies of economic development from the rich developed nations to the poor developing and under-developed nations is yet another important issue bothering the world leads. The world needs "no waste" or "low waste", "waste recycling" and "energy efficient" technologies for development. Technology for generation of energy from non-polluting and renewable sources and production of environmentally sager substitutes for industrial use and consumption

is yet another ecological necessity. The case of Chlorofluorocarbons (CFCs) required by refrigeration industries is a glaring example. We urgently need its safer substitute because a CFC destroys the protective ozone cover of the earth. The North nations produce and consume 98% CFC while the South only 2% and they are forced to phase out its production. *India and China* walked out from signing the Montreal Protocol on CFC production in 1987 because the North nations were neither prepared to provide the alternative technology nor any commitment to give funds for developing the technologies. They finally agreed to transfer better technology and funds at London summit in 1990.

Tha North nations believe that the technology development is commercial and those countries who want to utilise it must pay for it. The contention of the south is that North has acquired thosa technologies with the help of 'mind power' of the scientist and technocrats from the poor nations who migrated thera in saarch of better research facilities. Moreover they have created tha environmental problems and must feel obliged and indebted to transfer better technologies at nominal cost if not free to help solve those problems. Ona more view is that the White population of North are ecologically more susceptible end vulnerable to environmental degradation particularly global warming and ozone depletion. Non-White population of South with the virtue of melanin genes for bleck skin are better edapted to cope with radiation problem resulting from ozone depletion and heating problem resulting from green-house effect.

Concluding Remarks

The "Earth Summit" has left the world better informed about the environment, if not necessarily wise. It has helped to create mass awareness throughout the world against global environmental. degradation and the damage to the mother earth.

The most significant achievement of the summit was complete unity and unanimity among the South nations forgetting their political differences. Economic and political issues kept them apart but the ecological issues brought them together. India, China, Pakistan and other G-77 countries rallied together to face the onslaught of the North nations particularly the US and succeeded in creating division among the G-7 nations on environmental issues and impressed upon countries like Germany, Japan, Britain and France to realise the view point of developing countries In the process the United States of America was completely isolated

Role of US at Rio conference was most dubious and disappointing. She not only refused to sign the biodiversity treaty but also significantly diluted and watered down the climate convention. The American President George Bush arrogantly declared that conferences like Rio were not going to force the US people to change their pattern of consumption and give up the present so called extravagant life style. This reflects the general view of the American people. The European view especially that of Germany was more pragmatic. They realised that the culture of over-consumerism was wrecking the earth and that there has to be change in the present life style of the rich affluent nations of the North. India and other South nations made it clear in more assertive tone that the G-77 nations would no longer tolerate this culture of over-consumerism of North, which was being perpetuated, sustained and enjoyed on account of the under-consumerism, malnutrition and poverty of south. Development to ease the poverty of millions is more important than preserving the comforts of a few.

On two key issues, the South nations kept firm. There was no compromise on the issue of "Sovereignty" over the forest and bio-diversity reserves and that the "Eco-Fund" for Environmental Protection and Regeneration must be administered through more democratic end transparent authority where both the donors as well as the recipients have equal say. The developing nations fear that the environmental protection could become another instrument in the hands of developed nations to dictate economic and social policies in the Third World countries that are already reeling under external debt, growing poverty and other conditions imposed by the World Bank and the International Monetary Fund. Nevertheless, the developed nations have now realised for the first time that the question of environmental protection could no longer be considered in isolation from that of external debt and poverty also pollutes. This was another big achievement and a great success for the developing G-77 nations at the Rio conference.

Another significant achievement of the Rio meet was that it has served to highlight the gradual rise in the importance of NGOs lobbying and opinion forming groups in relation to global environmental conservation. In fact, it was due to pressure from the NGOs of different countries that forced the rich North nations to accept several of the terms of the poor South nations with regard to environmental conservation vis-a-vis economic development.

The Earth Summit firmly laid the foundation stone for a better world of tomorrow. Despite some disappointments, the achievements were big. Road to Rio which was started 20 years ago at Stockholm, Sweden, should march ahead with more vigour and enthusiasm towards a greener and safer world, where there is neither poverty nor pollution. Preservation of both the environments, the physical as well as social, is vital for the existence of mankind on earth.

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HARK : THE EARTH IS HEATING UP

Bajrang Lal Jethu

In the typical composition of unpolluted air, there is only less than one percent carbon-di-oxide In out atmosphere, a large quantity of Carbon-di-oxide gets introduced into the atmosphere from fossil-fuel-burning and breathing of animals. The carbon-di-oxide injected into the atmosphere does not remain there, about half of it gets utilized by plant-life or gets absorbed by the oceans.

Carbon-di-oxide absorbed by the oceans gets either precipitated or incorporated in aquatic-plants. In this respect these aquatic plants play an important role in maintaining carbon-di-oxide equilibrium between the atmosphere and the surface layers of the oceens

The other part of the carbon-di-oxide used by terrestrial plants, gets deposited in dead-vegetation and humus on forest flour or it goes into the soil after being eaten by the animals.

However, a large part of carbon-di-oxide is still left in the atmosphere This part of this gas can be used in growing plants because this gas influences the process of photosynthesis and so has a fertilizing effect. But we are going in an opposite direction Unmindful cutting of trees disturbs the carbon-di-oxide equilibrium and thus concentration of carbon-di-oxide is going up

It is well known fact that the temperature of the surface of the earth has been maintained by the energy balance of the sun's rays that strike the earth and the heat that gets radiated back into the space Carbon-di-oxide, being a green-house-effect gas, absorbs the heat reradiated by the earth and so prevents the radiation going into the space. In this way it gives a rise in the temperature of the earth's atmosphere that in turn reflects in the oceans.

This shows a way to find the change in global temperature The average rise in global temperature can be reckoned by measuring the

rise in the temperature of oceans. And for this very purpose velocity of sound is to be used. If there is a rise in the temperature of the oceans, the velocity ol the sound will also increase in the oceanic water.

The velocity of sound in the oceans' water is going to be measured under a project headed by the Institute of Oceanography California.

in collaboration with various countries and institutes of the world. Heard Island near Australia in the Indian Ocean has been chosen as the base-point for this experiment because all the five oceans are linked with this island by way of water channel.

A doctor uses *an instrument stethoscope for listening to the* breathing of the heart. Do we know how this instrument works ? In the pipes of a stethoscope interference of sound takes place. Due to this interference of sound, notes of our heart-beating get amplified and *become audible to our doctor. We need such type of pipes in oceans* to measure tha velocity of sound in them. And we have got such pipas.

Wa are very fortunate that there is a special type of water-layer, spread over in all the oceans of our globe. This water layer works as the pipes of a stethoscope. At Heard Island this layer is at the dapth of 245 metres from the surface of watar and at some other places in the oceans, its depth is more than 900 metres. So the oceans provide us with a natural path in the form of such water layer through which sound can travel This is due to the special characteristic ol the layer. Tha temperature of water above this layer is comparatively higher and the tamperatura of water below this layer is comparatively lower. In other words, the water layer above this layer is comparatively hotter and below this layer it is comparatively colder. In this way, it is in between two special natural boundaries and works as an acoustic-axis or wave-guide for the sound travelling in it. Again, due to its special boundaries, it makes the sound travel within the boundaries and prevents the scattering of sound waves. In this respect this layer is an acoustical channel spread over in all the oceans. There is a pipe- an acoustical channel, a wave-guide, a natural path for our sound signals.

In measuring *the velocity of sound the transmitter and the receiver* are established in the same wave-guide. So is the case with this experiment. This natural water layer is our wave-guide-acoustical channel, so the transmitter and the receivers will be established in this natural path.

The transmitter is to be established 245 metres below the surface of water at Heard Island This transmitter will send sound signals of

special frequency and intensity with high volume These sound signals will be received by very sensitive receivers, established deep under the water at different places of the world as the South Pole, Canada, India, South Africa, Australia, New Zealand and San Francisco. The distance between Heard Island and these other places is fixed, so the time taken by the sound signals can be calculated.

If the oceans are actually heating up, the time taken by the signals will decrease. It is estimated that this decrease will be a quarter of second in the period of one year.

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3

ESSENTIALITY AND TOXICITY OF CERTAIN TRACE ELEMENTS : A STRATEGY

Dr. D.C. Sharma

ELEMENTS AND LIFE

The whole matter on the earth is made up of atoms of about 103 elements shown in the periodic table of elements. (Fig. 1) Out of this, about 90 elements occur in nature But less than one third of them are present in living things The bulk of the living matter (98%) is made up of six non-metals: carbon, hydrogen, oxygen, nitrogen, phosphorous and sulphur. However, there are certain other elements which are *present in much smaller amounts, yet are essential for life.* These are-sodium, potassium, chlorine, calcium and magnesium. Some other elements are present in only trace quantities and have certain specific functions, for example, copper, cobalt, iron, iodine, manganese, molybdenum and zinc. Recently, a few other elements have *been found to be present in ultra trace quantities and are required for* growth and normal functioning of the body. These elements are silicon, selenium, vanadium, chromium, fluorine, tin, arsenic, and nickel. Thus these 26 elements are considered essential elements for life and the rest of the elements constituting bulk of the earth from which life has originated, are so far no considered essential. However, it may be possible that in future, some of these non-essential elements may be discovered to have *some essential functions.* The question why nature has selected only these limited number of particular elements for living systems is still not answered.

Most of the non-essential elements, especially certain heavy metals, are considered toxic to life. But it must be borne in mind that essentiality and toxicity are two sides of a coin. Depending on the nutritional state of the animal and other factors, an element may be *essential in a particular concentration or quality and toxic in another* concentration range (Fig. 2). The best known example is arsenic which

THE PERIODIC TABLE OF THE ELEMENTS

PERIODS	IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIII	VIII	VIII	IB	IIB	IIIA	IVA	VA	VIA	VIIA	NOBLE GASES
	1 H																1 H	2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	57 La*	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	89 Ac†	104 ‡	105 ‡													

• *Lanthanide series*

58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu

† *Actinide series*

90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

‡ No official names nor symbols have been adopted for these elements.

Fig 1 : The periodic table of the elements. All matter in the universe is made up of these elements which are here depicted by their symbols.

has reigned as "The king of poisons" for centuries but now it is also considered essential element for life in ultra trace amounts.

In the present article I will discuss the effect on human health of certain trace elements fluorine, selenium, lead and cadmium. The pollution of environment from fluorine and selenium is caused by nature itself, the pollution from lead and cadmium is man-made.

STRUCTURE OF ELEMENTS AND THEIR TOXICITY

It is well known that elements of same periodic group of periodic table (vertical columns in Fig 1) have similar structure and similar

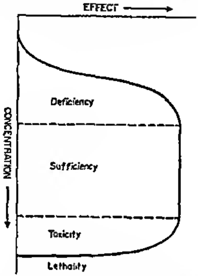

Fig. 2 : Curve showing the biological effect like growth, with increasing concentration of an element.

physical and chemical properties. This has important implications in biology and in the possibility of tha disease. Tha sizeable amount of a heavier element (one having higher atomic weight/number can displace a lighter one of the same group prasent in biological tissues and also alter its reactions. Moreover, when tissues have an affinity for *an element or are structured by it, they have an affinity for all other* elements for the same group. For example, calcium is present in bone so all other elements of II A group (Be, Mg, Sr, Ba, Ra) are bone seekers, and because iodine is present in thyroid gland, other group VII A elements (F, Cl) are also thyroid seekers. Similarly, all II B (Zn, Cd, Hg) and VI B (Cr, Mo, W) elements have affinity for liver and kidney.

The metals of same periodic group can interact in biological systems, especially if there is more amount of the larger than the smaller metal. Thus, silver has been found to displace essential element copper, bromine displaces chlorine, strontium displaces calcium, and rubidium/cesium displaces potassium. The displacement of zinc by cadmium, and sulphur by selenium also cause disease Theoretically, niobium can displace vanadiu, tungsten can displace

molybdenum, ruthenium can displace iron, rhodium can displace cobalt, and palladium can displace nickel. Similarly two essential elements of same group can interact, sodium and potassium interact and silicon can substitute for carbon in its structural functions.

The elements of the different periodic group can also interact antagonistically with each other if their ions have similar electronic structure of the valency shell. Thus iron and manganese act antagonistically and zinc (Zn^{2+}), cadmium (Cd^{2+}) and silver are antagonistic to copper. The above concept is also valid when anions are considered Thus chromate is antagonistic to vanadate and selenate to sulfate; hence sulfate to some degree prevents the toxic effects of selenate

Inorganic substances when enter into the body of an organism they are usually broken down into the ions which then interact with the constituents of cells, tissues, and target organs. For this reason, the toxic effect produced by an inorganic compound is generally determined by the toxicity of its ions In general, the toxicity of an element increases as its electronic stability decreases. In other words, the active the elements chemically, the more toxic it is. On this basis the decreasing order of toxicity of selected metal ions is given below for D magna and C subglobosa.

D.Magna.

Hg	Ag	Cu	An	Cd	Pb	Co	Cr	As	Ni	Fe
Sn	Ba	Mn	Be	Al	Sb	K	Ca	Mg	Na	

C. Subglobosa :

Ag	Hg	Cd	Cu	Zn	As	Pb	Mn	Mo	Sn	Co	Cr
Se	W	Te	Be	Zr	Ni	Fe	Sr	Al	Sb	Ba	K
Ca	Na	Mg									

FLUORINE

Fluorine, as its salt fluoride, is considered essential because of its well known effect on prevention of dental caries and in maintenance of normal skeleton. Recently it has been shown to be essential for growth and general development also. Its optimum concentration in drinking water is around 1 ppm. It is also present in blood Plasma fluorine level is 0 1 to 0.2 ppm. Daily intake of fluorides is about 4-5 mg

Fluorosis is toxic manifestation of excess fluoride present in drinking water. It is an example of pollution by nature. Fluorosis is a serious public health problem. An estimated 20-25 million people are affected in India. The disease is endemic in 12 states - Andhra Pradesh, Uttar Pradesh, Punjab, Tamilnadu, Karnataka, Maharashtra, Madhya Pradesh, Gujarat, Rajasthan, Haryana, Bihar and Orisa, and the union territory of Delhi. India is not the only country to have fluorosis as a serious health problem. Some of the other countries are Algeria, Argentina, China, Japan, Thailand and Kenya - which has the world's worst fluoride affected area. About 260 million people in the world are getting drinking water containing excess of fluoride.

Fluonde affects bones and teeth. Their inorganic part consist of hydroxyapatite crystals [$Ca_{10}(PO_4)_6(OH)_2$]. Since fluoride ion (F^{-1}) has the same size and charge as that of hydroxyl ion (OH^{-1}) and is more reactive, it replaces the latter forming calcium fluorapatite. At an optimum level of 1 ppm, fluoride present in drinking water prevents dental caries. Excess intake of fluorides from drinking water, vegetables or food continuously for a long time (5-10 years) affects both teeth and bones in humans as well as in animals. This is known as fluorosis. If the drinking water contains 3-5 ppm fluoride, it causes *dental fluorosis*, characterized by brown patches/discoloured teeth, pitting of enamel, corroded surface and structural alteration of the crown of the teeth. Excessive amounts of fluoride (more than 10 ppm) in drinking water causes *skeletal fluorosis*, which is characterized by stringing pain in the back and joints. The accumulation of fluoride in intervertebral discs causes stiffness of the backbone and hip joints. Calcification of ligaments effects the movements of muscles also. The affected persons have stiff-necks, bow-legs, and bent frame, and after some time their movements become totally restricted.

The treatment of water with lime and alum is recommended to remove excess fluoride from it before drinking. In India, there is no need of using fluoride containing toothpastes as the drinking water is having more than normal level.

SELENIUM

Selenium appears to be ubiquitous. However, its uneven distribution over the face of the earth results in regions with very low or very high natural levels of selenium in the environment. High seleniferous areas have been identified in many countries- North America, Ireland, Israel, Australia, South Africa, and former Soviet Union. Selenium poisoning is known for a long time; Marco Polo was the first to describe

the disease. It occurred in cattle, eating grasses and grains grown in areas of high selenium and was later on called as 'alkali disease' and 'blind staggers'.

It caused brittleness of the hair and hoofs and serious wasting of the body and lameness. The pain from the condition of hoofs is so severe that the animals are unable to move about for food and water and die of starvation. This condition is comparable to that of animals in fluorosis areas.

Levels of selenium in air (less than 10 $\mu g/m^3$) and water (few μg/litre) are usually very low. Food constitutes the main route of selenium exposure for the general population. Because of geochemical differences, the estimates of adult human exposure to selenium via the diet range form 11 to 5000 μg/day in different parts of the world. However, dietary intake more usually falls within 20-300 μg/day. The levels of selenium typically found in foods(mg/kg wet weight) is given below :

0.4 to 1.5 mg/kg - liver, kidney, seafood

0.1 to 0 4 mg/kg - muscle meat

0.1 to 0 8 mg/kg - cereals/ cereal products

less than 0.1 mg/kg - fruits and vegetables.

The highest blood selenium level in humans was reported in China in an outbreak of selenium poisoning (selenosis) The most common sign was loss of hairs and nails This may be explained by the fact that biological chemistry of selenium resemble sulphur which is its predecessor in group VI A of the periodic table (Fig. 1) As such selenium forms compounds selenocystine and selenomethionine, analogous to cystine and methionine amino acids formed by sulphur. These selenium containing amino acids are incorporated in tissue proteins in place of usual sulfur containing amino acids. Since nails and hair ara nch in cystine, replacement of this by selenocystine cause their pathology

LEAD

Pollution of the environment by lead occurs through mining, smelting and refining of its ore 'galena' (lead sulphide), burning of coal and petroleum fuels containing lead additives The organic compounds of lead tetraethyl lead and tetramethyl lead are used extensively as "antiknock" compounds in petrol and other fuels. Both

the lead compounds are volatile and poorly soluble in water, but trialkyl compounds formed from them in the environment are less volatile and more readily soluble in water.

A common man is exposed to alkyl-lead compounds present in motor exhausts. This is especially so in metropolitan cities and population living near highway where traffic density is high. Lead is also found in the soil, vegetation and animals in the vicinity of highways although its level decreases exponentially with the distance from the road. The concentration of lead in air varies from 2-4 $\mu g/m^3$ in large cities with dense automobile traffic to less than 0.2 $\mu g/m^3$ in most suburban areas, and still less in rural areas.

The toxic effects of inorganic lead has been documented in literature, but there is very little information regarding effects of alkyl lead compounds. Several epidemiologic studies have shown higher number of deaths due to cerebrovascular diseases and chronic nephritis in high lead exposed population (blood lead more than 80 $\mu g/100$ ml). In experimental animals and man, hematopoietic system was found to be most sensitive to lead. Exposure to lead produced anemia due to inhibition of certain heme synthesizing enzymes. Increased free erythrocyte protoprophyrin is a good indicator of exposure to lead. Blood lead concentration less than 50 $\mu g/100$ ml in adults and 40 $\mu g/100$ ml in children is regarded safe. Lead also affects central nervous system and lead encephalopathy has been reported. In this regard no effect level is about 60-70 $\mu g/100$ ml for adults and 50-60 $\mu g/100$ ml for children. The effects of lead on kidney are of two types. The first is tubular characterized by amino acids, phosphates and glucose in urine. This occurs with relatively short-term exposure and is reversible. The second type of renal effect is characterized anatomically by sclerotic changes and interstitial fibrosis progressively leading to reduced filtration capacity and renal failure.

In India with increasing urbanization and steep increase in motor vehicles, air pollution of lead is bound to increase enormously, unless remedial measures are taken.

CADMIUM

Cadmium ranks next to lead and mercury as an environmental pollutant. Zinc, cadmium and mercury are members of group II B of periodic table (Fig. 1) hence cadmium has many chemical, geochemical and toxicological properties similar to mercury. The three elements have similar distribution in rocks/ores. Hence cadmium and some

mercury are also produced in zinc smelters. Being volatile, a part of this cadmium is also released to the environment. Coal and other fossil fuels contain cadmium so their burning releases the element into the environment.

Human exposure to cadmium is mainly through the diet, which may supply as much as 50 μg from uncontaminated foods. If the soil is contaminated with cadmium, the plants grown on it will accumulate higher amounts of the metal (more than 1 μg/g) This actually occurred in Fuchu (Japan), where rice grown in the fields contaminated with effluent of a lead-zinc processing plant caused "*itai-itai*" ("ouch-ouch") disease characterized by rheumatic and myalgic pains. Shellfish, liver and kidney are rich food sources of cadmium.

After absorption, cadmium is transported in blood, bound mainly to blood cell and albumin. The element accumulates in kidney and liver. These organs contain an inducible protein, metallothione in which has high affinity for binding cadmium, zinc, mercury etc., which prevents other functional macromolecule from being attracted by these toxic metals. The half life of cadmium in the body is very long, i.e., 10-30 years. Consequently with continuous environmental exposure, the content of metal in tissues increase throughout the life. A number of reports have published linking renal cadmium level to hypertension but its causal relationship has not been established.

The *bidi* and cigarette smoking carries a serious danger of cadmium exposure as tobacco being its indicator plant accumulates cadmium from soil. One cigarette contains 1 to 2 μg of cadmium and even with 10% pulmonary absorption, the smoking of one packet of cigarettes per day results in intake of 1 mg of cadmium in a year.

In acute cadmium poisoning due to oral intake nausea, vomiting, salivation, diarrhoea and abdominal cramps occur. In long term exposure to cadmium, kidney is affected first. Renal injury may cause aminoaciduria, glycosuria, and proteinuria. Cadmium vapour are also harmful. It affects the lungs causing irritation, chest pain, nausea, dizziness, and diarrhoea. Toxicity may progress to fatal pulmonary conditions. Dyspnea is the most common complaint of patient with cadmium induced lung disease. Workers in smelters and other metal processing plants (electro-plating, galvanization and nickel cadmium batteries) may be exposed to high concentration of cadmium in the air.

In India, raised levels of cadmium (2-7 ng/cu.m.) is found in air in many cities-Bombay, Ahmedabad and Chandigarh. Plants, vegeta-

tion, animals and men near a zinc smelter run a greater risk of chronic exposure to high levels of cadmium and other related metals, unless adequate precautionary measures are taken. The ability of wheat and rice to concentrate cadmium from soil is yet another aspect which increases the chance of cadmium overexposure of population consuming crops grown in soil and water contaminated with effluent of a zinc-smelter.

SOME OTHER ELEMENTS

Molybdenum : Molybdenum is considered an essential element Human requirement is unknown and the intake is variable.but much less than 1 mg/day. High concentration of molybdenum in soil in Armenia has reported by exposed humans and livestock to high intake of this element (10-15 mg/day). As molybdenum is a constituent of enzyme, xanthina oxidasa activity and high serum uric acid levels which gava risa to high incidence of hyperuricemic gout.

Manganese : manganese is another essential elament. Ordinary diets supply about 4 mg/day, which is more than adequata. Manganese is among tha least toxic of tha trace elements. However, industrial exposure to manganese can produce toxicity state that resembles parkinsonism

Chronic manganese poisoning occurs among miners following prolonged working with manganese ores. A report of 150 cases of Morocco miners has published which described the symptoms - a *peculiar mask - like expression of the face, involuntary laughing,* a low voice with blurred speech, walking with spastic gait, and tremors of the hands.

Nickel : Nickel has been recently shown to be essential, Typical mixed diets generally consumed by western adults supply 300-500 μg nickel/day. Nickel is a relatively nontoxic element, so that nickel contamination of foods does not present a serious health hazard. However, exposure to nickel causes dermatitis in susceptible individuals. Its presence as an alloy in many types of jeweller makes it a leading cause of contact dermatitis.

EPILOGUE

Environmental pollution by toxic metals is a much more serious and much more dangerous problem than is pollution by organic substances such as pesticides because most organic substances are *degradable by natural processes while no metal is degradable. The*

metallic and elemental pollutants are going to stay in the environment for a long time. Therefore, every effort must be made to prevent the accumulation and contamination of toxic metals and elements in the environment by man's activities.

'Do nothing in excess', the wise Greeks said,
'Collectively or individually';
In every case, 'the piper must be paid'.
But man ignores his ancient history.
Each culture has within itself the seeds,
Of self-destruction, ruin, and decline.
When heedlessly, to satisfy its needs,
It flouts the pleas of Nature and of Time.
And so it's come to pass upon this earth;
Mankind has wrought excess of poverty,
Noise, poisons, hatreds, crimes, sex, Human Birth;
Excess of every thing but Charity!
Thus planets through their own pollution die,
And float as littered coffins in the sky.

-Harry de Metropolis

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4

LAND MANAGEMENT STRATEGIES : THERMAL POWER PLANTS IN INDIA

REKHA THAKRE AND A.L.AGGARWAL

INTRODUCTION

land is the primary and most essential resource for sustenance of living organisms in the biosphere The cultural evolution of man an important component of biosphere has led to utilization of natural resources by industrialization and urbanization. In these ventures, injudicious planning has ultimately resulted in serious environmental hazards jeopardizing man's own existence on the earth

Atmosphere just above the surface of the earth is an extremely tiny fraction of the total volume of our universe and only tiny space is available for human inhabitation Pollution of this tiny space along with the pollution of air, water, soil and vegetation would endanger the very survival of mankind. Development programmes and unabated urban growth as a consequence of fast development of industrial activities place an increasing strain on the infrastructural facilities as well as air, water and land resources in the country. With increasing industrialization, pollution control by various means is going to be a major concern and challenge for technologists of twenty first century.

Industries which are based on basic processes like crushing, grinding, combustion, sintering and various other chemical processes emit different types of pollutants being toxic and hazardous to ecosystem. The production of energy by thermal power plants (TPPs) ranks at the top of the list of such pollution intensive industries. The pollutants generated in this industry contaminate air, water, and biota in the zone of influence which ultimately find its respite on land.

The land degradation around TPPs is the most common phenomena observed throughout India making it imperative to focus

our attention at this causative factor so that correct steps can be taken for existing as well as proposed power generating industrial units.

THERMAL POWER GENERATION IN INDIA : A SCENARIO

Energy is an essential governing factor for economic development and for improving the quality of life. In India per capita consumption of commercial energy viz., coal, petroleum and electricity is only one eighth of the developed countries of the world although there is tremendous increase in gross domestic sector along with improvement in the living standard of people.

Today, electricity is the most convenient and versatile form of energy. The power industry has recorded a phenomenal rate of growth both in temporal and spatial scale as a result of technological sophistication over the last few decades. Electricity plays a crucial role in both industrial, commercial and agricultural sectors and thus the consumption of electricity in the country has been used as an indicator of productivity and growth. With this perspective, power development has been given high priority in the development programme of our country.

The actual power generation during 1985-87 was 42,591 MW comprising 1,095 MW from nuclear power plant, 14,470 MW by the hydro power plant and 27,026 MW from TPPs. This power generation capacity further increased by 50.1 % within a half decade. In the year 1991, the total power generation was 64,820 MW, out of which 18,440 MW hydro, 1,470 nuclear and 44,910 TPP. Locations of thermal power stations in India are shown in Fig. 1.

In TPP, coal is the prime raw material used for steam generation. In India, coal resources are quite substantial, available mostly in Andhra Pradesh, Arunachal Pradesh, Maharashtra, Madhya Pradesh, Bihar, Assam, Nagaland, Meghalaya, Orissa and West Bengal. Coal is the most economic and easily available fuel for power generation. Its reserves in the country are estimated at 85,075 million tones including cocking, semicoking, non cocking tertiary coals and lignite (CIL, 1989). These reserves are expected to last for quite some time ensuring its long term availability. Power sector is the major coal user in Indian industry (Table 1).

Out of the total power production in India more than 60 per cent is generated through TPPs using coal (India 1990). Most of these plants are based on non cocking coal except for Neyvelli plant running on lignite. Use of oil and natural gas for power generation is restricted to

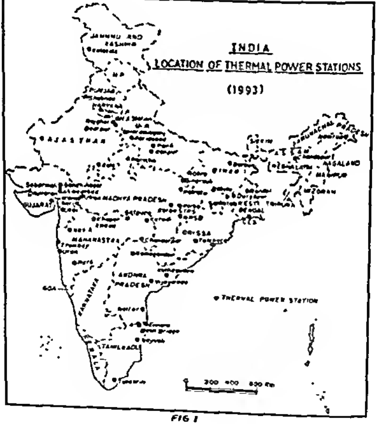
INDIA
LOCATION OF THERMAL POWER STATIONS
(1993)
THERMAL POWER STATION
NAGALAND
ORISSA
GOA

FIG 1

specified sectors such as refineries, petrochemicals etc. and does not exceed one percent of the total power generation.

Table 1 : Coal Consumption : Industrial Sectors, India

(million tones)

Sector	1976-77	1978-79	1983-84	1988-89
Power	27.0	33.7	55.2	87.3
Steel	22.3	24.6	28.7	32.4
Railway	13.3	13.5	12.0	10.0
Domestic	7.7	8.5	10.4	10.8
Other	28.8	33.6	46.4	56.7
Total	99.1	113.9	152.7	197.2

Thus, coal for energy generation will be the primary commodity at least for a few more decades to come.

Nevertheless, during the energy production, the solid combustion products are voluminous and pose the threat to environment if not managed properly. There has to be stringent management strategies lest the land the most precious and limited resource of the ecosystem will be contaminated to a point of no return. For the delineation of management strategies it is essential to know the implications involved due to the interaction of emissions from TPP and the various components of ecosystem.

TPP Pollution and Environmental Pathways

The current usage of coal by Indian utilities results in the production of over 26.2 million tones of solid combustion by-products each year (1988-89). An approximate doubling of coal usage within the next ten years has been predicted which is bound to intensify the challenges associated with proper disposal of the wastes. Stringent particulate removal requirement and increased application of desulfurization systems will further increase byproduct volumes. Extensive utilization of coal ash is both technically and economically feasible, yet less than 20% of utility coal ash produced in India is presently being used (Ahluwalia et. al. 1985) Disposal of these wastes to land is then the only option in most cases. Nevertheless, land disposal is not

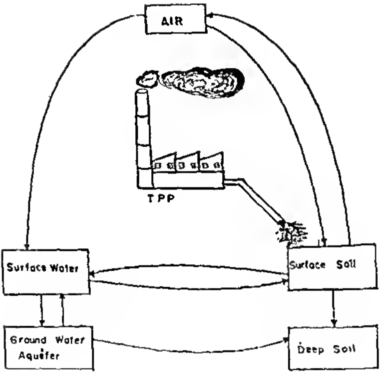

Fig 2 : Enviormental Pathway of Pollutants in Various Components of Ecosystem.

without environmental risks The schematic of environmental pathways of pollutants produced in thermal power generation through various components of ecosystem has been projected in Fig 2.

Current Waste Disposal Practices : Indian Overview

The solid byproducts resulting from coal combustion in TPPs are : bottom ash (slag), fly ash and flue gas desulfurization (FGD) residues in some cases. The disposal of these wastes practiced in India is by landfilling and ponding. Mine dumping of ash is strongly advocated but its current practice is less-than 2%. Landfilling and mine disposal options are used to dispose of solids and dewatered sludges while ponding is used for disposal of slurries or for interim storage prior to various treatments.

Although most coal ash is currently handled in wet systems and disposed of in ponds, the national trend is toward dry collection and land filling A number of factors have been responsible for this change, including recently proposed and promulgated Environmental (Protection) act (1986), the vast amount of ash being generated and increased awareness for non-acceptance of pollution by masses

Mine disposal of these wastes is not very wide spread in India due to transportation cost factor making it uneconomic

In reviewing the environmental issues related to the disposal of the combustion products, an understanding of the properties of the three by-product wastes is essential.

Chemical Composition and Characteristics of Ash

The chemical composition of coal ash is dependent on the composition of soil strata from which the coal is mined. It is a function of the geology and hydrogeology of the surrounding strata Coal ash has all the major constituents of clay composition in variable proportions (Table 2).

Table 2 : Typical Levels of Ash Constituents (%)

	Fly ash	Bottom ash.
SiO_2	40-60	50 60
Al_2O_3	20-35	15-25
Fe_2O_3	3-6	4-9
CaO	3-20	4 15

Table 3 : Characteristics of Particles Observed on the Surfaces a Various Sites Around TPP and Fly Ash Collected fror ESP (%)

Site	Distance (metres)	Direction	*Flyash* particles (Glassy sphericals)	*Irregular* Shaped particles (Silicate shale minerals	Black round particles (magnetite spheres Fe_3O_4	red particles (Red ferric oxide) Fe_2O_3	Coal particles (Carbonaceous matter)	Road dust particle
1	500	W	35 2	10 11	3 2	1 5	0 52	48 48
2	1000	W	27 9	8 62	2 4	0 5	0 31	60 27
3	2000	SW	3 2	0 9	0 3	NT*	NT*	10 6
4	1000	NE	30 6	10 81	3 8	1 2	0.61	50 18
5	1000	E	36 06	32 73	15 98	20 18	5 6	0 0
6	1500	E	28 20	13 63	2 3	0 8	16 5	36 71
7	2000	E	20 03	15 08	1 8	0 3	20 81	41 98
8	4000	E	5.8	0 6	0 6	NT*	NT*	76 8
Fly ash from ESP	0	-	46 32	19 77	25 18	7 05	1 83	0 0

NT = Not traceable, ESP = Electrostatic precipitator

Silica, alumina and iron oxide represent about 90% of the total (Table 3). Because of the high temperature at which flyash is produced in a high efficiency boiler, the ash consists of glassy particles (Generally spherical) of complex silicates of these three elements (Thakre and Thergaonkar, 1982). In addition to the major constituents, coal ash contains other elements in variable quantities. Virtually all the naturally occurring elements in the soil and identified on the Periodic table can be found in the coal ash However, it is not uncommon to see two orders of magnitude variations in trace element concentration between samples. Table 4 lists the typical ranges for the more common trace elements in TPP coal ash

Table 4 : Common Trace Elements : Coal Ash

Range (mg/kg)	Trace elements
100-1000	B Ba, Cu, Mn, Sr
10 100	As, Cr, La, Mo, Ni, Pb, T1, U, Zn
1-10	Cd Sb, Se, T1, V
< 1	Hg

Although some sulfur can be removed from coal as pyrites in coal washeries and some sulfurdioxiode is removed by absorption/adsorption by the ash, most SO_2 must be removed by FGD scrubber systems. Wet scrubbers produce a sludge that results from contacting flue gases with an alkaline solution or slurry. The major components of FGD sludge are : Calcium sulfite, calcium sulfate, flyash, excess reagent and process water.

The proportions of these particulate systems will vary depending on the presence of efficiency of upstream particulate systems and the extent of oxidation

The FGD sludges which are predominantly calcium sulfate, dewater more easily and to a greater degree than the sulfite forms. Presence of sulfate is beneficial to the handling and physical characteristics of the product after disposal (EPRI 1990).

Ash Disposal on Land and Environmental Concerns

Potential interactions of the environment with land disposal utility wastas are numerous. Some of the trace elements in coal ash projected in Table 4 when present in high enough concentrations are phytotoxic, some toxic to fish and other aquatic organisms and soma hava adverse effects on humans and animals. The environmental issues of concern due to land disposal of ash are

- Effects on local air quality
- Effects on soils and terrestrial vegetation
- Aquatic biotoxicity
- Effect on ground water
- Effect on surface water
- Disposal site wash out.

Effects on Local Air Quality

Dry flyash is readily lifted up even due to small breezes during transportation, dumping, spreading and even in idle conditions due to least cohesive forces in fine solid particles. The climatic conditions throughout major part of Indian Continent can be classified as dry tropical with temperatures ranging from 30-45 °C almost for 8-10 months. At such temperature variations, the rate of evaporation losses from ash ponds are quite high rendering it completely dry in upper surface layers Air pollution from such disposal ash ponds is a

perpetual problem usually plaguing the people living adjacent to ash ponds, being particularly severe in summer

Part of the ash pond is usually dry and the hot winds blow the ash into the neighbourhood An empirical equation developed by US EPA predicts the emission, E from ash storage piles as

$$E = 1.9 \left(\frac{S}{1.5}\right)\left(\frac{365 - P}{235}\right)\frac{F}{15} \qquad \text{kg/ha/day}$$

Where S = percent fraction < 40 micron

P = no. of days greater than 0.25 mm of precipitation per year

F = % of time the unobstructed wind speed exceeds 20 kmph

Table 5 : Pollution Levels Monitored Around Ash Pond

Pollutant	Concentration level (ug/m^3)		
	Mean	Sd	Range
SO_2	26	± 44	3-104
NO_2	24	± 21	3-58
SPM	1015	± 258	755-11335

Assuming S as 10%, P 3 months of rainy season (i.e. 90 days) and F as 15% the emission works out to be 14.82 kg/ha/day or 10.292 ug/sqm/minute The concentration levels of suspended particulate matter in the air can go upto several thousand ug/m^3 of air (NEERI Report, 1988) Actual pollution levels monitored in area adjacent to ash dumping yard are higher than the threshold limit and substantiate the predicted value (Table 5) These SPM levels are crossing ambient air quality standards promulgated by CPCB even at minimum level (less than 10 percentile). These minimum level low values were monitored when the winds were almost calm conditions (78%) while winds more than 10 kmph were never recorded during sampling period. Studies carried out for monitoring of ambient air quality around thermal power plants indicate that the effect of resuspension of pond ash in air can be experienced both on biotic and abiotic components of ecosystem more than 2 km distances in downwind directions.

Effects on Soils

When utility coal combustion residues are deposited on land, the soil becomes enriched in salts (sulfite, sulfate etc) resulting in variation in physical and chemical properties of the soil mixture

Table 7 : Calculated Deposition Rates of SPM as a function of Size at Various Distances from TPP (mg/m2/Yr)

Sr No	Size Range	Distance (m)								
		500	1000	1500	2000	3000	4000	5000	6000	8000
1	< 8.5	–	–	–	–	352 68	51 48	553 0	604 8	622 1
2	8 5-14 5	–	–	–	–	426 0	648 0	967 7	1054 1	1257 4
3	14 5-25 5	–	–	–	311 04	12532 0	4083 2	5859 2	6472 8	6472 8
4	25 5-45	–	–	–	985 0	5011 2	12295 1	21029 7	23449 0	22545 4
5	46-55	–	319 7	570 2	2583 4	14152 3	32348 2	46455 0	45957 0	40435 2
6	56-65	–	337 0	1417 0	8087 0	4035 2	60870 0	97044 4	88357 4	63141 12
7	65-100	–	12.131	68 992	307 6	502 4	404 4	226 45	359 42	83 85

Table 8 : Calculated Deposition Rates of Trace Metals at Various Distances from TPP (mg/m2/Yr)

Dist. (Km)	Mn	Pb	As	Ni	Cu	Zn	Cr
1 0	22.29	1 008	0.229	1 42	8 48	71.23	18 92
1 5	150.26	7.25	1 56	9 81	62.06	490 31	13.10
2 0	549 57	25.31	5.58	35 06	222.1	1762.71	46 46
3.0	1036 35	43.78	10 89	67 02	452.97	3407.20	87 0
4 0	1100 94	39 79	11 99	72.63	466.03	3755.59	91 0
5 0	942.92	27 86	10 62	63.70	411 48	3392.35	76 25
6.0	771 39	19 91	8 63	52.89	342 78	2881.15	61 41
8 0	505 04	10 37	5.9	35 46	230 73	2011.93	39 12
Enrichment g/100kg soil in 10 year	72.1	2 51	0 8	11.2	31 0	245.1	62.1

Enrichment has been calculated for 0.15 cm soil depth in 10 K.M. radius assuming the point source in the centre of heavy metals around

TPS indicates that Cr and Zn top the ranking followed by Mn while Pb and As have the geoaccumulation index less than 1. (Fig 3) (Aggarawal & Thakre, 1988). The geo-accumulation index greater than one is said to have adverse effect on soil micro and macro flora

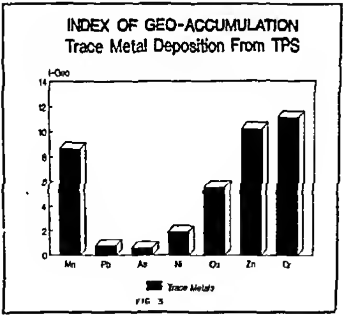

Fig. 3

Table 7 : Calculated Deposition Rates of SPM as a function of Size at Various Distances from TPP (mg/m2/Yr)

Sr No.	Size Range	Distance (m)								
		500	1000	1500	2000	3000	4000	5000	6000	8000
1	< 8.5	–	–	–	–	362 88	51 48	553 0	604 8	622 1
2	8 6 14 5	–	–	–	–	406 0	648 0	957 7	1054 1	1287 4
3	14 6-25 5	–	–	–	311 04	12592.0	4363 2	5659 2	6472 8	6472.8
4	25 6-45	–	–	–	986 0	5011 2	12286 1	21029 7	23449 0	22645 4
5	45-55	–	319 7	570 2	2583 4	14152 3	32348 2	46466 0	46987 0	40435 2
6	56-65	–	337 0	1417 0	6087 0	4035 2	80870 0	97044 4	88957 4	63141 12
7	65-100	–	12.131	83 992	307 6	502 4	404 4	228 45	359 42	69 88

Table 8 : Calculated Deposition Rates of Trace Metals at Various Distances from TPP (mg/m2/Yr)

Dist (Km)	Mn	Pb	As	Ni	Cu	Zn	Cr
1 0	22.29	1 008	0 229	1 42	8 48	71 23	18 92
1 5	150 26	7.25	1 56	9 81	62 06	490 31	13 10
2 0	549 57	25 31	5 58	35 06	222.1	1762 71	46 46
3 0	1036 35	43 78	10 69	67 02	462.97	3407 20	87.0
4 0	1100 94	39 79	11.99	72 63	466.03	3755 59	91 0
5.0	942 92	27 86	10 62	63 70	411 48	3392 35	76 25
6.0	771 38	19 91	8 83	52 69	342 78	2881.15	61 41
8 0	505 04	10 37	5 9	35 46	230 73	2011.93	39 12
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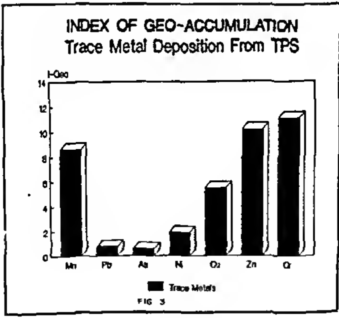

Fig. 3

Chronological order of soil enrichment by various toxic trace metals studied at Korba TPPs airbasin has been found to be :

Cr > Zn > Mn > Cu > Ni > Pb > As.

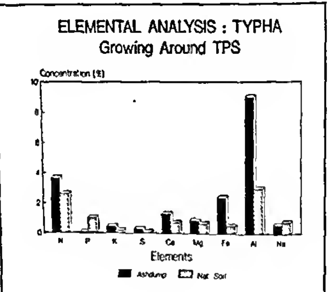

FIG 4

Phytotoxicity

The leaching of utility waste constituents into soil becomes a problem for plant life in all areas on and around a disposal site because of the accumulation of soluble salts and trace elements (Thakre et al. 1991). Soil salinity plays a major role in inhibiting vegetation growth starting from germination level (Thakre & Thergaonkar, 1985). Natural plant succession is very slow and the pioneer plant species are those which are capable of thriving in high saline and marshy lands such as cattail (*Typha* spps.) a weed which in turn can become a nuisance problem if not properly managed in time (Thakre & Aggarwal, 1987). It has been claimed that many plant species can grow on fly ash disposed lands. The naturally growing typha plants on old ash dumps have shown stunted growth. The chemical analysis of these plants revealed that the inorganic constituents of fly ash were present in elevated concentrations in the above ground parts of the plants as compared to the plants growing on natural soils (Fig 4). Further, biochemical analysis of these plants incited that the incraased levels of these elements impose the invisible stress on metabolic activity of the plants (Thakre 1983). The activity profile of peroxidase and catalase enzymes was found to be correlating with the increased elemental profile in the plant body (Fig 5.) However, the forage grown on waste ash residues with elevated toxic trace metals needs extra caution as the cattles consuming the forage may induce possible physiological disorders in the individuals as well as cross media transfer of these elements.

Groundwater Effects

The leachates from improperly sited and designed waste disposal ponds and landfills represent the potential threat of contamination of groundwater supplies Thakre et.al. 1986). This could occur in inadequately lined ponds, providing a greater opportunity for ground water contamination, since the soil below the impoundments is always saturated and under considerable hydraulic head (Theis et. al 1978). For this reason seepage under ponds may be constant in duration and greater in volume than leachate from a landfill. This potential problem of unlined disposal systems may be overstated. Few disposal sites in India are lined. Also, due to scarcity of land and transforming the land unproductive after ash disposal activity, Department of Environment and Forest has gone very strict in granting permission to TPP to acquisition of more land for ash disposal. Available land area for ash disposal in few of the TPPs in India is shown in Table 9. Instead,

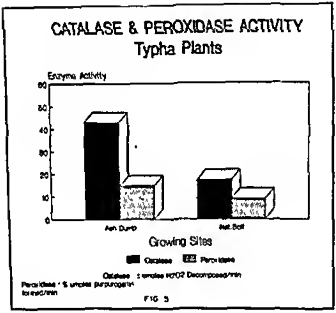

Fig 5

already sanctioned lands have to be used further by constructing tall bunds for accommodating more ash being continuously generated. This, however, will intensify the leaching to ground water stratum

Nevertheless, this problem has not yet attracted the attention of researchers in India.

Table 9 : Fly Ash Disposal : Actual Acquired Land (1985)

Plant	*Generation (MW)*	*Pond Size(ha)*
Farakka	2500	918
Korba	2500	2660
Koradi	1080	176
Ramgundam	600	450
Singrauli	1050	1200
Vindhyachal	1260	2200
Kota	640	246

Not all ground water quality degradation is related to the presence of trace matals. Waste constituents such as Fe, Al, Ca, Cl, SO_4 and SO_3 are not generally regarded as hazardous. They are includad in the secondary drinking water standards. These macro-constituants can increase hardness, salinity, alkalinity end dissolved solids, depending on the natural background water quality.

Effects on Surface Waters

The disposal of utility coal combustion by-products, whether in a landfill or in a pond, can have significant effects on nearby surface waters if sufficient precautions are not taken. Adjacent water bodies usually get contaminated through surface run off from a disposal site, lateral migration of leachate and/or discharge of pond effluents (Table 10).

Table 10 : Trace Metal Concentrations : Ash Pond Run-off Water

Metal	Conc. mg/1
Cd	0 001
Cr	0 26
Ni	0.35
Zn	0.566
Cu	0 656
Pb	0 533

When a stream or any other inland water does become contaminated, the first impact is usually noticed in the fish and other aquatic organisms. *Concentration levels of trace elements in water* considered toxic to aquatic organisms are at lower levels than those considered harmful to terrestrial animals, humans and vegetation For example, concentrations of As, Cd, Cr, Hg, Ni and Pb as low as 0 01 mg/1 can have serious effects on certain aquatic species.

Direct discharge of effluents in water bodies has been strictly regulated by CPCB, requirements. However, it is a general observation at most of the thermal power stations in India that the surface run off and lateral migration are the mechanisms prevalent in ash pond area creating problems in surface waters competing with direct discharge problems in surface waters competing with direct discharge (Thakre & Thergaonkar 1982)

Discharge Site Wash Out

A less frequent but potentially more serious contamination problem is the washout of wastas dua to flooding An example of this catastrophic event occurred during 1981 in Koradi with the resulting dastruction of several acres of standing crops, and cattles. (Hitvada News Agency 1981). Since power plants ara usually located near water bodies for tha easy availability of watar for cooling purposes, thera are many disposal sites in India which have been situated within reach of a major flood plain on a nearby river. However, the opinion survey of the masses residing in tha vicinity of TPPs (Koradi, Korba and Khaparkheda) revealed that sporadic instances of fly ash overflowing with low intensity is a common phenomena encountered in the vicinity of thermal power ash dumping locations but has not been documented.

Radioactivity from TPP Wastes

It is well known that *coal and its ash exhibits slight radioactivity* of natural origin. This is not unexpected, since the earth's crust contains two elements : Uranium and Thorium in various concentrations which form "background radioactivity". The radioactivity of these two elements is a result of their direct retease and that of their decay products of radium and radon isotopes. Since coal is present in various geological tormations containing trace amounts of U and Th, it also contains traces of U and Th depending upon the content in formations. Numerous studies have been performed on the ashes of various coals (18). Since the combustion of U and Th forms insoluble

and non-volatile compounds that pass completely into the ash, the concentrations in ash can be predicted based on the coal/ash ratio.

In looking at the radioactivity levels of coal ash, it is important to view the data in perspective with the natural radioactivity of common materials which man is always exposed to (Table 11).

Table 11: Radioactivity of Common Materials

Materials	Radioactivity (pCi/g)	
	Uranium	Thorium
Coal ash	3 - 5	3 - 5
Granite Blocks	2 - 5	2.2
Clay Bricks	0.6 - 3	1.2 - 3.5
Cement	0.7 - 3	2 - 3.5

The amount of radiation due to coal ash disposal has been estimeted to be 0.1% of that resulting from natural background radioactivity when tha entire population is concerned (Wilson & Jones, 1974). Therefore, tha contribution of a coal fired power plent to background radioactivity is negligible

Mitigation Strategies

The potential environmental pathways discussed so far clearly high-light that there is an urgent and stringent need to tackle the adverse impact of disposal operation of TPP waste. Recovery and restoration of flyash contaminated solid in India can be achieved through various ways as shown in Fig. 6 which can broadly be classified as under:

- Natural Mitigation Strategies
- Engineered control strategies.

Natural mitigation strategies

Soil buffering Capacity: Physico-chemical characteristics of flyash are the governing factor for the processes to undertake to recover the contaminated soils. Most of the time the pH of Indian flyash falls in alkaline range from 8.5 and above due to high concentration of alkaline and alkaline earth metal oxides formed during high tempera-

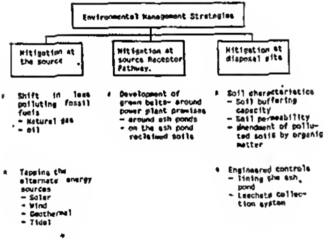

Fig. 6 : Flow diagram showing environmental management strategies for recovery of TPP ash contaminated soil.

ture combustion of the coal. However, in certain Eastern and North Eastern sectors the pH of flyash is in acidic range.

pH of the soil at disposal site plays an important role in solubilizing the toxic trace metals. The mobility of metals in soils is strongly dependent on soil specific characteristics. For example, the soil can

exert a buffering influence over the flyash leachate by raising or lowering the pH. The solubility of most trace metals (the notable exceptions being As and Se) tend to decrease with increased soil pH because the metals precipitate and/or adsorb onto hydrous ions and aluminum oxides in this pH range.

Organic Matter Amendment on Polluted Sites

Clay content and the presence of organic matter in soil can also strongly affect attenuation of trace metals. Clay serves two functions *by adsorption of metal ions from leachate, as well as retardation of* water movement due to small pore size and low permeability. Organic matter in soil can chelate metals. For example, the mobility of Cd, Pb and Ni in soils is limited since the clay-organo fractions of the soil have a high affinity for these heavy metals.

Low Soil Permeability : Soils with lower permeability will be the best sites to prevent groundwater contamination due to leaching from ash dumps. The flyash contaminated soils are high in inorganic metal oxides *which further are converted to hydroxides in presence of water.* Such inorganic substratum inhibits and hampers the growth of microflora in these soils. Addition of organic matter in the form of green manure helps in microbial activity. The initial successional plant species growing on saline soils of ash dump area should be chopped and buried under the soil. This will increase the organic matter content in these soils.

Abatement of Air Pollution by Green Belt : This is the concept with multiplicity of objectives to control air pollution from ground level sources. The selection of plants in these sites specifically will be governed by two factors :

- Plants capable of growing on saline soils/waters
- *The selected plant species should* be *used only for the* purposes other than as a stock-feed for live stock as well as human beings to avoid cross media transport of toxic elements.

The green *plantation will prevent the horizontal aerial dispersion of* ash from the ponds in dry weather conditions. Also, it will help control horizontal/lateral migration of effluent/seepage in the soil to considerable extent.

The plantation sites at this industrial activity should be all around power plant premises, along the roads within the complex, around ash pond and on the ash pond reclaimed soil.

The selection of plants to grow on these contaminated soils needs special consideration as the vegetation growing on these sites will have higher concentration levels of micro and macro plant nutrients This may pose a threat to the animals surviving on these vegetation. Hence, the plants grown on these soil should strictly be used for the purposes other than the edible.

Engineered Control

These engineering disposal systems can control the migration of leachate from disposal sites. A few of the common control methods are :

- lining the ash ponds: economically not practiced at present due to cost-involved. There are various lining materials tested and advocated.
- Leachate collection systems: The leachates from ash ponds are collected and disposed of otherwise, not contaminating the natural water systems.

However, these engineered control systems will mostly be applicable in designing new disposal facilities. Since Environmental (Pollution) Act apply also to existing disposal facilities, many sites may need to be upgraded to comply with the regulations in force To assist utilities facing the need to upgrade abandoned or currently operated disposal sites there are many ways.

These utilities can be provided with design guidelines and alternative selection procedures for upgrading existing waste disposal facilities. However, some basic indepth scientific investigations are essential before implementing the designs as ash disposal basically remains to be a site specific problem .

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□□□

5

CONTROL OF SO_2 EMISSIONS FROM FOSSIL FUEL-FIRED STEAM ELECTRIC GENERATING PLANTS

Ashok Kumar Mahbubani

1. INTRODUCTION :

1.1 General : *Most commonly released combustion products by* fossil fual-fired steam generation plants ara solid incombustible, ash particles of vanous types and sized and gases which include carbon dioxide. Of these matenals sulfur dioxide, nitrogen oxides and articulates require special attention.

Trace quantities of uranium end thonum and their products of redioactive decay are released in fly ash and are of negligible public health significance. Other trace substances such es mercury arson-ic, copper, iron, lad etc and polycyclic organic matter (Products of incomplete combustion of fuels) also may be present.

The rate at which pollutants are emitted from a power plant burning fossil-fuel depends upon type, quality and quantity of fuel burned, the design of boiler and furnace and the combustion system used.

1.2 SO_2 Emissions : Among the gaseous air pollutants the sulfur dioxide have historically major attention because of their common occurrence and known harmful effects at high concentrations. The sulfur dioxide in stack emissions from fossil fired power plants are directly proportional to sulfur content of the fuel. For gas fired plants the quantity is usually-insignificant, fuel oil used in power plants vary in *sulfur content from less than 1/2% to more than 4 % weight and cools* vary about 1/2 % to more than 5%.

Sulfur is present in coal as organic sulfur, sulfur and pyrite and in oil as sulfides, and thiophenes. When coal and fuel oils are burned in

power plants, 90-95% of sulfur appears as SO_2 and 1-3% as SO_3 in the stack gas cleaning equipment, because of the large capacity of most modern fossil fueled power plants and the high sulfur content of fuel used in many locations, SO_2 emissions from many plants exceed 500 tons/day, some plants on occasions exceeding 2000 tons/day.

2. HARMFUL EFFECT AND AIR QUALITY STANDARDS :

When SO_2 is discharged in atmosphere, it is further oxidized forming sulfuric acid and sulfates which typically account for 5-70% of the suspended articulates in urban areas. The increase in the atmospheric humidity results in the enrichment of the ratio of sulfuric acid to sulfur dioxide. Higher percentage of relative humidity is also accompanied by larger sizes of sulfate particles and sulfuric acid droplets. Sulfate particles are generally between 0.2 and 2.0 in diameter, thus they are important in respiratory effects and light scattering.

An average man can detect about 3 ppm of SO_2 by odour and taste, SO_2 at 10 ppm concentration cause irritation to throat, eye and nose The maximum concentration endurable for one hour or more than is 15 ppm A content-ratio 50 – 250 ppm of SO_2 causes death of the human being

Vegetation injury is caused when SO_2 concentration is more than 0.5 ppm. Plants are most susceptible to SO_2 injury at heading and at early panicle formation. Formation of rice plants with 1.5 or 10 ppm SO_2 results in respiratory 10.30 and 50 percent decreases in tha yield. The corrosion properties of SO_2 in materials is more serious at higher humidities, higher temperatures and in the presence of particulate material.

3. METHODS OF SO_2 EMISSION CONTROL :

Since total removal of SO_2 is practically impossible, ways and means have been devised for bringing as down the concentration to tolerable levels as stipulated by Government in various countries These methods can be classified into three groups :

1. Use of low sulfur fuels
2. Dilution by tall stacks
3. Reduction of the concentration level of SO_2 in the stack gas by subsequent treatment

3.1 Use of Low Sulfur Fuels : Historically, regulatory efforts for power plant SO_2 control have been directed lo control of emissions at the source. These efforts generally have been in the form of limitations on sulfur content of power plant fuels.

Scrubbing H_2S from sour natural gas with monoethanolamine or similar solvent has long been common practice. The resulting H_2S has been flared and when sulfur recovery was practiced, it was usually done by the claus process. This process is a dry catalytic conversion process which produces molten sulfur.

Low sulfur coal has been obtained by selective mining and also by washing or treating the coal to remove the sulfur, by these methods, ara not considered Coal gasification method appears to be the suitable one will ba chosen for using our vast coal reserves without causing pollution The coal gas is scrubbed of sulfur and other unwantad materiels end converted to methane lo echieve high celorific velue. The conversion to methane is difficult but highly desirable for permitting the continued use of present gas burning equipment.

3.2 Dilution by Tall Stacks : Atmospheric dilution has presentad many acute problems with SO_2. Stacks up to 4/5 melres in height have been erected for smelter gasas end to 300 m. high for power plants. Dilution will continue lo serve a useful purpose until direct control methods ere feasible. During edverse meteorological conditions the dilution has accompanied by switching of fuels at power plants and curtailment of operation at smelters.

3.3 Reduce the Concentration Level of SO_2 In Ihe Stack Gas by Subsequent Treatment : There are more than 50 SO_2 removal processes under various stage of development. Many of them are subsidized by environmental protection agency in its quest lor the best way to remove relatively dilute SO_2 from flue gases. These removal processes can be broadly divided in two parts : 1. wet processes, 2. dry processes.

3.3.1 Wet Processes :

3.3.1.1. Water scrubbing : The cheapest absorbent for this purpose will be water and it was patented in Japan. By this process it is possible to reduce the concentration level to 100 ppm. It involves scrubbing of tail gas containing SO_2 with water. The solution of SO_2 in water may be heated and or kept under vacuum to evolve a mixture of water vapour and SO_2 concentrated. SO_2 may be obtained by condensing out the water vapour. This process does not involve the

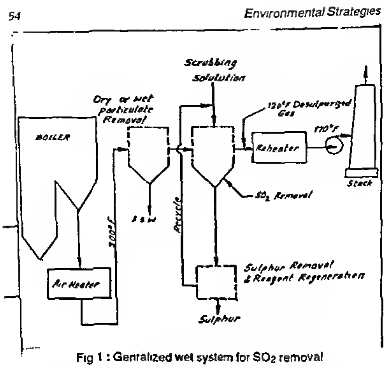

Fig 1 : Genralized wet system for SO_2 removal

use of any costly absorbers. Low pressure steam available in plant can be utilized for stripping

3.3.1.2 Ammonia scrubbing : In this process the stack gases are scrubbed with aqueous ammonia solution and the product when reacted with sulfuric acid in another stage yields ammonium sulfate. The reactions are :

1. $NH_4OH + SO_2 = (NH_4)_2 SO_3 + H_2O$
2. $(NH_4)_2 SO_3 + SO_2 + H_2O = 2NH_4 HSO_3$
3. $2NH_4H SO_3 + H_2SO_4 = (NH_4)_2 SO_4 + SO_2 2H_2O$
4. $(NH_4)_2 SO_3 + H_2SO_4 = (NH_4)_2 SO_4 + SO_2 + H_2O$

Ammonium sulfate as a byproduct is produced as solution which can be concentrated to recover ammonium sulfate and sold as fertilizer.

Flow sheet of this process is shown in Fig. 2.

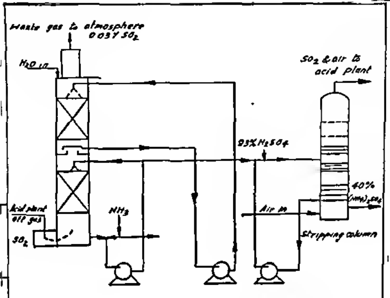

Fig. 2 : Flow sheet of "Cominco" process : Absorption of SO_2 in Ammonia Sollution.

In a process developed by consolidated mining and smelting CO. Ltd. SO_2 is absorbed in an aqueous ammonium sulfate in a packed tower using wood packing, the temperature of desorption si kept below 35 °C *to maintain favorable equilibrium for the absorption. The* absorbed SO_2 is liberated by addition of 93% H_2SO_4 while NH_3 is converted to ammonium sulfate.

Another process uses ammonium sulfate bisulfite solution for scrubbing. The resulting solution is treated with nitric acid to produce ammonium nitrate which can be used as fertilizer and regenerate the SO_2.

$$(NH_4)_2SO_3 + SO_2 + H_2O = 2NH_4HSO_3$$

$$(NH_4)HSO_3 + HNO_3 = NH_4NO_3 + SO_2 + H_2O$$

$$(NH_4)_2SO_3 + 2HNO_3 = 2NH_4 + SO_2 + H_2O$$

It is necessary to use oxidation inhibitor to minimise formation of ammonium sulfate. A control level of 100 ppm can be obtained.

By this process control level achievable is less than 100 ppm. The lime after absorption is held in delay tank to do supersaturate the sulfate. The solids after centrifuging is sent to storage. The main

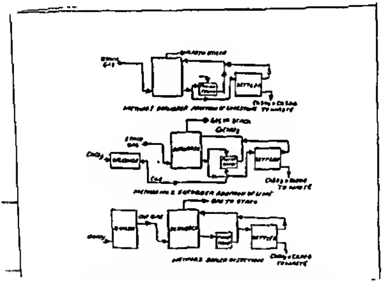

Fig. 4 : Major process variation in use of Lime or Limestone of SO_2 from Stack Gases.

problem in this method is tha disposal of solid calcium sulfate. This process has the advantage of minimum extra space requirement. This process is shown in Fig. 4.

Soma processes are also utilizing the scrubbing of organic solutions e.g. dimethyl aniline and/or xylidine The asarco DMA process employees scrubbing with dimethyl aniline and economical only for SO_2 gas concentration above 2%.

Several processes have been developed using cake and neutral gas as a reducing agents. In one of the processes of SO_2 reduction to sulfur is done with H_2S and CH_4.

3.3.2 Dry Processes : This can be further subdivided into three sections :

3.3.2.1. : Process using metallic oxide or hydroxides as adsorbents.

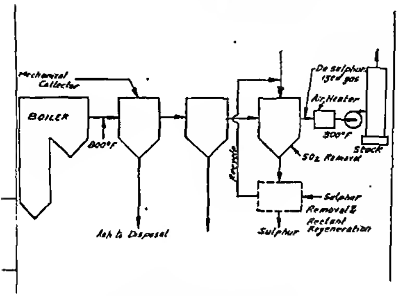

Fig 5 Generalized Dry System for SO_2 removal

3.3.2.2 : Process using solid absorbent.

3.3.2.3 : Process based on catalytic oxidation.

3.3.2.1 Removal of SO_2 metallic or hydroxides or sorbents : SO_2 *reacts with alkali and alkaline earth oxides to yield metal sulfate* (MSO_3). If oxygen is present part of the sulfite is converted to MSO_4. This reaction is used for the removal of SO_2 from coal and fuel combustion sources. In general reaction is given below :

$$MO(s) + SO_2\,(g)\;1/2\,O_2\,(g) \longrightarrow MSO_4\,(s)$$

Alkalized alumina process uses a Co-precipitate of sodium and sodium oxides (with oxides approximately 20% wt) absorbent particles. The fall proceeds downwards and the gases rise upwards. SO_2 is oxidized first and then it reacts with metal oxide to form sulfate

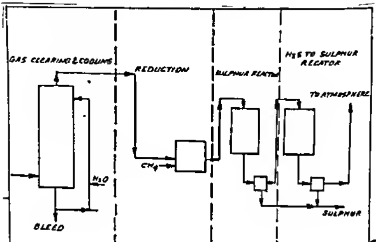

Fig 6 : Reduction of Sulfur Dioxide to Sulfur.

The spent absorbent is regenerated by contacting with producer gas. The regenerator effluent containing H_2S is processed for recovery of elementary sulfur. Flow sheet of alkalized alumna process shown in Fig- 6

A process developed by central electricity board employs for removal of SO_2 by treating the solids with synthesis of gas ($CO + H_2$) at 650-700 °C. Elemental sulfur is recovered from hydrogen sulfide.

Mitsubishi Heavy Industries has developed a process using maganeseoxide Mno as sorbent. The temperature in the entrainment type absorber is 100-180 °C. A part of magnenese oxide reacts with SO_2 forming sulfate About 90% of the solids leaving the absorber are

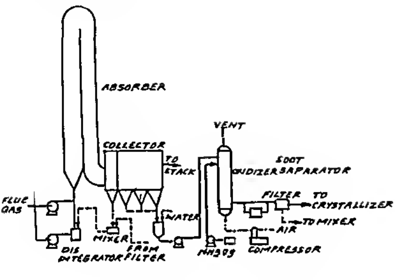

Fig 7 Mitsubishi Manganese Oxide Process

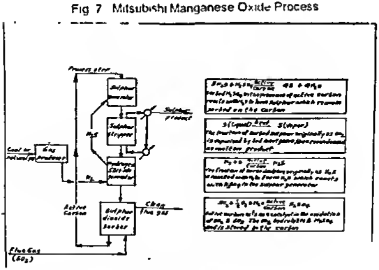

Fig 8 : Westvaco activated carbon process.

collected in Cyclone and returned for recirculation. Remaining solids are collected in an electro static precipitator which are mixed with water slurry of NH_3 and air yielding $(NH_4)_2SO_4$ and the sorbent which is recirculated.

Flow sheet of this process is shown in Fig. 7 & 8.

3.3.2.2: Removal of SO_2 by solid adsorbents: Well known method in this type is Westvaco process. This process consists of four steps, SO_2 removal, sulfer regeneration, sulfur regeneration, sulfur recovery and internal hydrogen sulfide reductant production. All steps of the process are carried out in continuous counter current multistage fludized bad equipment. In the sulfur dioxide removal step, the SO_3 is removed usually at 300-350 °C stack gas temperature to evoid condensation problem The flue gas is then cooled to 150-300 °C for SO_2 removal by carbon catalyzed reaction of the SO_2 with oxygen in the flue to form sulfur trioxide which is subsequently hydrolysed to sulfuric acid and srobed in carbon pores. This overall sorption reaction is given by following equation.

$$SO_2 + O_2 + H_2 \xrightarrow[150\text{-}300°F]{\text{Activated carbon}} H_2SO_4(\text{sorbed})$$

The carbon then flows to the next fluid bad where the H_2SO_4 on the carbon at 300 °F reacts with hydrogen sulfide to form elemental sulfur which remain in the carbon pores This sulfur generation reaction given by equation.

$$H_2SO_4(\text{Sorbed}) + 3H_2S \xrightarrow[300°F]{\text{ActivateddCarbonn}} 4(\text{sorbed})$$

The sulfur loaded carbon flows to fluid bad sulfur stipper, where one fourth of this absorbed elemental sulfur is recovered from the carbon by direct vaporization at about 1,000 °F using recycled inert gas. The remaining elemental sulfur on the carbon is then reacted with hydrogen at about 1000 °F in the fluid bad Hydrogen sulfide generator provides the hydrogen sulfide needed in the first step of regeneration by equation 3.

$$3H_2 + 35\ (\text{Sorbed}) \xrightarrow[1,000\ °F]{\text{Activated Carbon}} 3\,H_2S \qquad ....(3)$$

The hydrogen for hydrogen sulfide generator is supplied by an external gas producer or reformer. Thus the regenerated carbon is as continuously recycled back to the SO_2 removal process stop.

Sifting has reported another process which uses a polymer resins. This process is not yet commercialized.

The applications of molecular sieve for absorbing SO_2 from tail gas has been established but this technique is not yet commercialized.

3.2.3 Removal of SO_2 by Catalytic Oxidation : Two processes have been developed for the removal of SO_2 especially from power stacks by catalytic oxidation The catalysis used is V_2O_5. The product is H_2SO_4.

MONSENTO PROCESS :

Wet gas taken directly from the boiler at 510 °C and passed

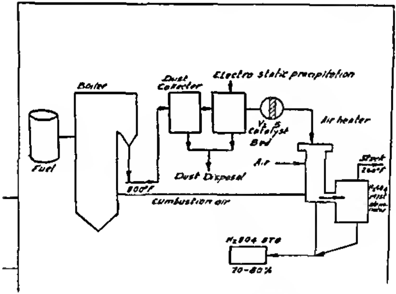

Fig 9 : Catalytic oxidation flow diagram.

through electrostatic precipitator is fed into a catalytic convertor for conversion of SO_2 to SO_3. Subsequent absorption yields 77% concentrated acid The draw backs of this process are the high capital *costs and operating costs and the products acid concentration* Flow sheet of this process is shown in Fig 9

ABSORPTION PROCESSES :

The process for applicability must be capable of achieving the goal economically. It is possible to analyse the process from various angles. But it is the overall analysis that will help in selecting the best

Resin absorption is the best process from technological capability point of view as it can achieve zero ppm removal and it is also flexible The processes with no subsequent disposal problem, normally designated as regeneration processes are MgO absorption, potassium sulfate bisulfite methyl ammonium sulfite active charcoal basis aluminum sulfate bisul-fate and resin absorption method.

The lime absorption process is the simplest and requires minimum extra space, 1000 Sq ft for 250 T/day of acid point.

These processes are good for reducing concentration levels well below 500 ppm. Generally, for smaller plants lime absorption method is recommended. For large plants magnesium oxide absorption and methyl ammonium sulfite bisulfite methods appear most attractive

CONCLUSION

It is necessary to take all possible precautions for minimizing the release of SO_2 to atmosphere because of the harmful effects of SO_2. This is of particular importance in the care of urban areas, with large size of population and innumerable factories. Tail gas treatment processes can be adopted depending on the local availability of the adsorbent and the market for the byproduct if any. But it requires detailed economic studies to select a process for a particular situation.

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6

ENVIRONMENTAL HEALTH IMPACT PROFILE OF LIME KILNS AT MAIHAR

Neeta Chaturvedi and Ajay K. Awasthi

INTRODUCTION :

The life supporting system on earth consisting of lithosphere, hydrosphere and atmosphere together forms the "biosphere". Man has been exploiting natures free goods to fulfil his basic needs since long In the past few decades the rate and extent of exploitation of natural resources have increased tremendously due to materialistic approach and raised standard of living. This is ultimately resulting in the destruction of this beautiful planet; the "Mother Earth".

Environmental Impact Assessment introduced in the USA as national environmental policy act (NEPA) in 1969 is one technique which has attracted the attention of scientists, policy and decision makers all over the world. EIA techniques are used to predict the long term and short term impacts of any major activity. The EIA finds ways to reduce unacceptable impacts and shape the project, so that it suits the local environment.

The lime kilns are structures built up to meet the lime requirement of the country and have the serious impacts on the local environment In the present study an attempt has been made to highlight various health impacts caused by lime kiln activity at Maihar.

MATERIAL AND METHODS :

Study Site : Maihar is situated in the south-west of Satna district and lies in north-eastern part of Madhya Pradesh. Maihar is a well developed tehsil of Satna and is very famous for Sharda Devi Mandir. It is situated on National highway no.7 along railway line of central railway (Bombay-Hawarh).

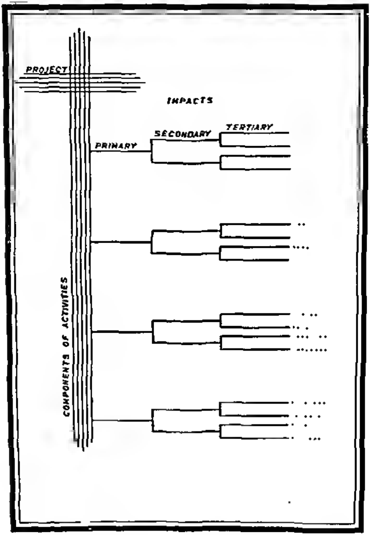

Fig 1 : Conceptual Framework of Impact Network.

The Network Method :

The method attributed to Sorenson (1971) Is probably the best known method for investigation higher order impacts. The object of the network approach is to display in an easily understandable formate, the intermediate links between a project and its ultimate impacts Network analysis identifies various Interrelationships between caused factors of an operation and the impacted environmental Items. From these operations primary, secondary, tertiary, tetrary impacts associated are identified and scored (Canter, 1971). The network is actually shown in the form of a tree also called a relevance or impact tree to express higher order impacts. An impact network thus provides an overview of all impacts caused or induced by the project and its related activities in the form of branches of a tree. (Fig. 6.1) The method involves two steps.

(i) Estimation of the occurrence probabilities of the individual chain of events in e branch of a tree on an arbitrary scale ranging from 0-1 (where "0" represents no possibility of occurrence and "1" the highest possibility).

(ii) Estimation of the total Impact score on the basis of weighing scheme epproach. The weighing scheme approach requires two aspects :

   (a) Magnitude of the impact upon the specific environmentel factors.

   (b) Weighing of the degree of importance of the particular action on the environmental factor in the specific instance under analysis.

An arbitrary scale ranging from 1 to 10 is used for magnitude and importance ratings. A plus or minus sign is allotted to the magnitude number expressing beneficial or adverse impacts. After tracing out all impacts the probability of occurrence, magnitude and importance rating scores are allotted to each impact and the calculation is done in following steps :

- Probability of occurrence (P) of a branch

$$P = Pa \times Pb \times Pc \ldots$$

(Where Pa, Pb, Pc... = probability of occurrence each of Impact)

- The total branch score (IM) is equal to

$$IM = a(M \times I) + b(M \times I) + c(M \times I)$$

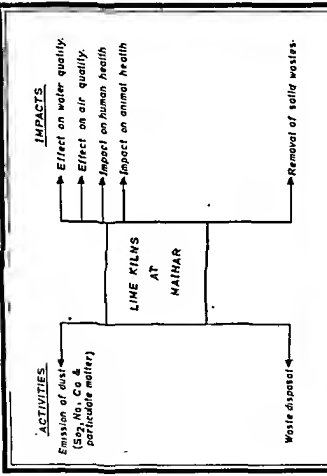

Fig 2 MAJOR ACTIVITIES AND THEIR IMPACT.

(Where M=Magnitude score, I-Importance score, a, b, c.. impact)

- The weighted impact score (w) is equal to

W=P x IM for a branch.

- The expected environmental Impact (EEI) Is equal to the summation of weighted impact score of total branches

$$EEI = \Sigma w$$

Field Survey : An intensive field survey was conducted in the area to identify various health impacts due to lime kiln on the people living around and also on the workers engaged in lime manufacture.

IMPACT ANALYSIS :

In present study various health Impacts were visualized and scored. The scoring have been done for probability of occurrence, magnitude and importance values obtained on the basis of an opinion survey poll end on views of an expert panel.

Network description involves two major steps for health Impact analysis The first step identifies two major lime kiln activity and five primary heelth Impacts (Fig 6.2). In the second step 19 branches were developed through the five primary impacts considering secondary, tertiary end tetrary Impacts (Fig 6.3).

The over all expected environmental health impact score comes to be -460.974. The values for each impact is presented in Table 1.

Hypothetical Impact Assessment Scale (HIAS) for Impact Comparison: A hypothetical impact assessment scale was developed by giving hypothetical maximum and minimum probability, magnitude and importance values to each impact. The maximum and minimum impact levels were identifies as + 100% and + 10% in hypothetical scale. The expected health impact score (-460.974) when placed in the hypothetical scale reveals that the calculated values falls in between 60% to 70% of HIAS (Table 2.)

OVER VIEW OF ENVIRONMENTAL HEALTH IMPACT :

On the basis of opinion gathered from medical experts the long term and short term exposure to lime kiln may cause following health problems :

1. **Short term exposure :** Conjuctivities, laryngities, Coryza, Bronchites, Domalites, Rhintes etc.

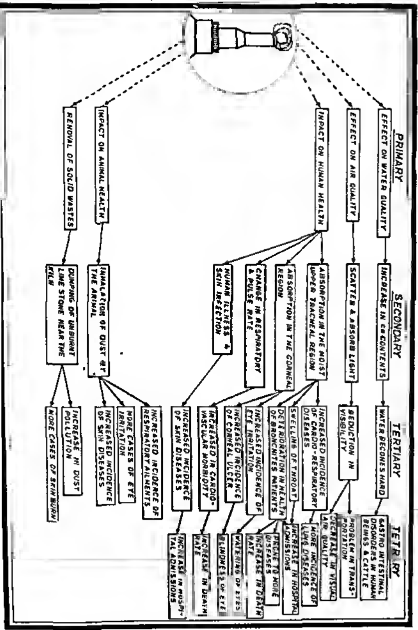
PRIMARY
SECONDARY
TERTIARY
TETR RY
EFFECT ON WATER QUALITY
EFFECT ON AIR QUALITY
IMPACT ON HUMAN HEALTH
IMPACT ON ANIMAL HEALTH
REMOVAL OF SOLID WASTES
INCREASE IN ca CONTENTS
SCATTER & ABSORB LIGHT
ABSORPTION IN THE MOIST UPPER TRACHEAL REGION
ABSORPTION IN THE CORNEAL REGION
CHANGE IN RESPIRATORY & PULSE RATE
HUMAN ILLNESS & SKIN INFECTION
INHALATION OF DUST BY THE ANIMAL
DUMPING OF UNBURNT LIME STONE NEAR THE KILN
WATER BECOMES HARD
REDUCTION IN VISIBILITY
INCREASED INCIDENCE OF CARDIO-RESPIRATORY DISEASES
SWELLING OF THROAT
DETERIORATION IN HEALTH OF BRONCHITES PATIENTS
INCREASED INCIDENCE OF EYE IRRITATION
INCREASED INCIDENCE OF CORNEAL ULCER
INCREASED IN CARDIO-VASCULAR MORBIDITY
INCREASED INCIDENCE OF SKIN DISEASES
INCREASED INCIDENCE OF RESPIRATORY AILMENTS
MORE CASES OF EYE IRRITATION
INCREASED INCIDENCE OF SKIN DISEASES
INCREASE IN DUST POLLUTION
MORE CASES OF SKIN BURN
GASTRO INTESTINAL DISORDERS IN HUMAN BEINGS & CATTLE
PROBLEM IN TRANS-PORTATION
DECREASE IN VISUAL AIR QUALITY
MORE INCIDENCE OF LUNG DISEASES
INCREASE IN HOSPITAL ADMISSIONS
INCREASE IN DEATH RATE
PRONE TO MORE DISEASES
WATERING OF EYES
BLINDNESS OF EYE
INCREASE IN DEATH RATE
INCREASE IN HOSPI-TAL ADMISSIONS

Table 1 :

CHES	PROBABILITY OF OCCURRENCE PRI SEC. TER. TET	TOTAL	IMPORTANCE AND MAGNITUDE VALUE PRI SEC. TER. TET	WEIGHED IMPACT SCORE (W) TOTAL	W = P X IH
1	1 x 5 x 1 x 1	5	(10x-8) + (3x-3) + (10x 7) + (7x-5)	-194	97
2.	1 x 5 x 1 x 1	5	(10x-8) + (3x-3) + (10x-7) + (10x 7)	229	·14 5
3	1 x 3x 5x 5	075	(10x-8) + (3x 1) + (3x-1) + (3x 1)	[illegible]	-6 [illegible]75
4	1 x 3x 3x 5	045	(10x-8) + (3x 1) + (1x 1 + (5x 7)	-119	-5 35[illegible]
5	1 x 3x 3x 25	0225	(10x-8) + (3x-1) + (1x-1) + (5x[illegible]	[illegible]	-2 521
6	1 x 3x 8x 1	24	(10x 5) + (3x-5) + (3x-5) + (10x-4)	120	-28 80
7	1 x 3x 25x 1	0 0075	(10x 5) + (3x-5) + (3x-5) + (1x 1)	-81	-0 067
8	1 x 3x 1x .1	03	(10x-5) + (3x 5) + (10x-8) + (1x-1)	-146	-4 38
9	1 x 3x 1x 1	3	(10x-5) + (3x 5) + (10x-8) + (10x 5)	-195	-58 50
10	1 x 3x 1x 1	09	(10x-5) + (3x 5) + (10x-8) + (5x 1)	-150	13.50
11	1 x 3x 7x 7	.147	(10x 5) + (1x-3) + (5x 3) + (5x-3)	-83	-12.201
12	1 x 3x 1x 1	003	(10x-5) + (1x 3) + (1x 1) + (1x-1)	-55	-0 165
13	1 x 5x 1x 1	005	(10x-5) + (5x-3) + (1x-1) + (1x 1)	-67	-0.335
14	1 x 5x 5x 1	025	(10x 5) + (5x-3) + (5x-7) + (1x-1)	-101	-2 525
15	.7 x .2 x 6x	064	(10x-5) + (3x 1) + (3x-5)	-68	-5 712
16.	7 x .2 x 6	056	(10x-5) + (3x 1) + (3x-3)	-62	-3 472
17	7 x .2 x 1	014	(10x-5) + (3x-1) + (1x 1)	-54	-0 756
18	1 x 75x 5	375	(10x-7) + (7x-5) + (10x 10)	-205	-76 87
19	1 x 75x .3	.225	(10x-7) + (7x-5) + (5x-3)	-120	-27 00

Expected Environmental Impact Score (EEIS) = ΣW

NEGATIVE SCORE = 460 974

The over all score ΣW = − 460 974

Table . 2 : Hypothetical Impact Assessment Scale (HIAS) (Expected Environment)

SCALE	PM I	PMI	PMI	PMI	PMI	PMI	PMI	PMI	PMI	PMI
VALUE	1 10 10	999	888	777	666	555	444	333	222	111
(+) ( ) IMPACT PERCENT SCALE	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%
VALUE FOR ONE BRANCH	400	212	105	47	19	06	02	3	025	0004
VALUE FOR 19 BRANCH	7600	4028	1995	893	381	114	38	5.7	475	0076
POSITION OF EXPECTED ENVIRONMENT IMPACT OVER ALL SCORE			-460 974							

Expected environment impact score — P = Probability of occurrence

Negative score = 460 974 — M = Magnitude

Over all score = 460 974 — I = Importance

2. Long term exposure : Chronic obstructive air way disease, restrictive airway disease, Chronic conductivities, Dermatites.

An independent survey work indicates that there is increased incidence of ling disease among the lime kiln labourers. Diseases which are much prevalent among the workers are as follows :

(i) **Cough :** 45% more among loboure rs than others.

(ii) **Tuberculosis :** Prevalent among all the age groups and sex

(iii) **Lung disease :** More among workers having been employed for more than three years

(iv) **Watering of eyes :** All workers affected

(v) **Swelling of throat occasionally**

(vi) **Nausia** Prevalent among all.

(vii) **Coryza** Prevalent among all.

The approximate number of patients (%) estimated to be affected due to the exposure of lime dust/emissions from lime kiln falling under various heads are as follows :

		ACUTE %	CHROMIC %
(a)	EYE	4-10	80-90
(b)	LUNGS	60-70	50-60
(c)	HEART	—	—
(d)	EAR	–	–
(e)	THROAT	20-30	40-50
(f)	SKIN	10-20	20-30.
(g)	HAIRS	05-06	10-12
(h)	KIDNEY	—	—

RESULT AND DISCUSSION :

Net work analysis in the present investigation reveals that the lime kiln activity in area is impacting the human health adversely (EEIS : -460 974) and the magnitude of negativity of the impacts is 60%-70%. It is concluded from the study that the majority of population is suffering from respiratory disorders, skin disease and gastrointestinal disorders. There is a high prevalence of disease among workers because of unhygienic working environment and mode of charging the kiln. Labourers while climbing up to the parapet of the kiln to charge it usually take deep breath and consequently high doses of toxic gases. The temperature at the lime kiln and surrounding areas is usually high The human body has a very sensitive temperature control mechanism but the failure of the body to adjust the heat stress produces disorders resulting in heat stroke, heat cramp, exhaustion dehydration and heat syncope. Combination of work load and heat stress during working in lime kiln may cause disbalance in thermoregulatory mechanism and normal physiological mechanism leading to heat collapse. The CO and SO_2 are the two main toxic emissions from the lime kiln. The carbon-monoxide combines with blood haemoglobin to form carboxyhemoglobin and deprive the body tissue with much needed oxygen resulting in anemia The second most toxic gas is SO_2 which affect various regions of pulmonary track and the eye because of its acidic nature on hydration. The continuous inhalation of lime dust may cause gastrointestinal disorders.

It is suggested that to reduce air and water quality loss and related health problems changes should be devised in structural architecture of lime kilns by using chiminies, filters etc So that it emits less particulate matter and toxic gases. Labour working conditions should be improved with particular reference to measures to prevent heat and

toxic gases impacts and a proper health care facility should be provided to the working class To improve the immediate environment, a large scale plantation belt should be raised at least of a half width around each lime kiln

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7

PRINCIPLES AND PROBLEMS IN WATER RESOURCE MANAGEMENT

S.K. AGARWAL

INTRODUCTION

Water is essential not only for the sustenance of human life and activities but for the 'quality of life' as well (Chaturvedi, 1975). It is the essence of life on earth and totally dominates the chemical composition of all organisms. The ubiquity of water is biota as the fulcrum of biochemical metabolism rests on its unique physical and chemical properties. It provides both food and drink and has been used for recreation, transport, cooling, waste disposal and more.

Nearly every community has a water problem. One-fourth of the population today is troubled with water shortage, poor water or both, and the prospects are for even more difficulty in the future. It is generally recognised that at least in our country water is no longer available in unlimited quantity. It is already a scarce commodity and in terms of its requirement, it is destined to become more and more scarce.

Our natural water resource since decades have been subjected to different levels of ecological stress, by increasing pace of green revolution, population explosion, urbanization and industrialization in public and private sectors. So long as the stress are within elastic limits, the resource tend to recover to the original state, but once, the elastic limit is crossed, irrevocable stresses are set and the distorted equilibrium does not return to the original ecological equilibrium observed under no stress condition (Shrotriya, 1984).

Rainfall : Although the average precipitation over the country as a whole is about 1000 mm, this is very unevenly distributed in space and time. The west coast and the Assam regions are areas of heavy rainfall, receiving 2500 mm and above annually. The eastern part of

the peninsula and the northern plains receive moderate rainfall of 1000 2500 mm annually. The Punjab plains and upper western part of the Deccan plateau receive low rainfall of 250 - 1000 mm. While the Rajasthan desert and Ladakh plateau of Jammu and Kashmir are regions of very low precipitation of less than 250 mm. The bulk of the precipitation occurs in the south-west monsoon period covering 4 to 5 months of June to October. A large part of the country experiences acute water shortage in the other months. It is only the south - eastern coast of peninsular India that receives the major shares of the precipitation in November and December from the north - east monsoon (Murthy, 1975)

Assessment of Water Resources Only 3 percent of the total global content of approximately 1.4 billion cubic metres of water, is fresh and suitable for human use. Of this again 77.2 per cent is permanently frozen, 22 4 per cent occurs as ground water and soil moisture, 0.35 per cent is contained in lakes and wetlands, and less than 0.01 per cent is in rivers and streams. Thus fresh water is very limited resource.

The water resources of India can be primarily classified under two heads, viz., (a) *Surface water resources*, and (b) Ground water resources.

Surface Water Resources

As a rough estimate, the annual rainfall over the whole country would be equivalent to about 3700 billion cubic metres, Of this, around 1250 billion cubic metres is lost by evapo-transpiration, and another 790 billion cubic metre by seepage into the soil, thus leaving 1660 billion cubic metres as surface flow into the river systems. Fourteen major river systems share 83 per cent of the drainage basin, accounts for 85 per cent of the surface flow and serve 80 per cent of the total population of the country. There are other 44 medium and 55 minor rivers which are mostly seasonal in nature. However, all the river water flow cannot be utilized because of the numerous limitations, Imposed by topographer, climate, soil condition etc. It has been estimated that only about 666 billion cubic metres of water can be utilized from various rivers without large inter-basin water transfers. Moreover, because of uneven distribution of rainfall over the year, it becomes necessary to store up the flows in the monsoon period for regulated release during the non-monsoon months. (Murthy, 1975).

The area and volume of surface waters on earth have Increased because of the impoundment of rivers to form both medium and large

7

PRINCIPLES AND PROBLEMS IN WATER RESOURCE MANAGEMENT

S.K. AGARWAL

INTROOUCTION

Water is essential not only for the sustenance of human life and activities but for the 'quality of life' as well (Chaturvedi, 1975). It is the essenca of life on earth and totally dominates the chemical composition of all organisms. The ubiquity of water is biota as the fulcrum of biochemical metabolism rests on its uniqua physical and chemical properties. It provides both food and drink and has been used for recraation, transport, cooling, waste disposal and more.

Nearly every community has a water problem. One-fourth of tha population today is troubled with water shortage, poor water or both, and tha prospects are for even more difficulty in tha future. It is generally recognised that at least in our country water is no longer available in unlimited quantity. It is already a scarce commodity and in terms of its requirement, it is destined to become more and more scarce.

Our natural water resource since decades have been subjected to different levels of ecological stress, by increasing pace of green revolution, population explosion, urbanization and industrialization in public and private sectors. So long as the stress are within elastic limits, the resource tend to recover to the original state, but once, the elastic limit is crossed, irrevocable stresses are set and the distorted equilibrium does not return to the original ecological equilibrium observed under no stress condition (Shrotriya, 1984).

Rainfall : Although the average precipitation over the country as a whole is about 1000 mm, this is very unevenly distributed in space and time The west coast and the Assam regions are areas of heavy rainfall, receiving 2500 mm and above annually. The eastern part of

the peninsula and the northern plains receive moderate rainfall of 1000 - 2500 mm annually. The Punjab plains and upper western part of the Deccan plateau receive low rainfall of 250 - 1000 mm. While the Rajasthan desert and Ladakh plateau of Jammu and Kashmir are regions of very low precipitation of less than 250 mm. The bulk of the precipitation occurs in the south-west monsoon period covering 4 to 5 months of June to October. A large part of the country experiences acute water shortage in the other months. It is only the south - eastern coast of peninsular India that receives the major shares of the precipitation in November and December from the north - east monsoon (Murthy, 1975).

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The area and volume of surface waters on earth have increased because of the Impoundment of rivers to form both medium and large

reservoirs (Fels and Keller, 1973), and because of the construction of countless small farm-ponds and stock-tanks (Dendy, 1963). By March 1981, India has constructed about 1554 major dams along with several medium and small ones with a storage capacity of about 1,60,352 million cubic metre (Mahajan, 1985).

Ground Water Resources :

It as been estimated that out of about 790 billion cubic metre of water that seeps into the soil, about 430 billion cubic metre remains in the top soil layers and produces soil moisture which is essential for growth of vegetation. The remaining 360 billion cubic metre percolates into the porous strata and represents the actual enrichment of underground water. Out of this, the water that can be extracted economically is only about 255 billion cubic metra (Murthy, 1975).

The Importance of Water : Water exists as water vapour and as spatially limited water formations below, on and above the earth's surface. Water resources are water formations which can be utilizad by human society. Water vapour and water formations are dynamic; they ara always in motion (Figure 1) and their stata of aggregation is forever changing. These processes continue without interruption, change in space and time and transform the natural environment (Jermer, 1987).

Table 1. Estimated water use and projected requirements in billion litres/day (Chaturvedi, 1975).

Use	Type	1973-74	1978 79	1988 89	2000-01
Domestic	NC	34.20	49 78	60 50	85.00
	C	17.42	21.95	30 90	43 50
Industrial	NC	12.30	18.90	47 20	151 00
	C	0 93	1 49	3 58	11 58
Agricultural	NC	1333.15	1718 23	2562 70	4093 00
	C	807 76	1038 79	1531 20	2380 38

NC = Non consumptive use, C = Consumptive use

Our natural water resources have always been subjected to conflicting uses. we are all different in some way, yet each of us has a fair - share need of water. Many of the priorities which we set for use of that fair - share compete and conflict with priorities set of others.

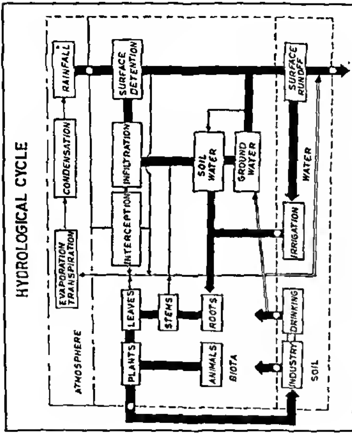
HYDROLOGICAL CYCLE
EVAPORATION TRANSPIRATION
CONDENSATION
RAINFALL
SURFACE DETENTION
INFILTRATION
INTERCEPTION
SOIL WATER
GROUND WATER
SURFACE RUNOFF
WATER
IRRIGATION
LEAVES
STEMS
ROOTS
PLANTS
ANIMALS
DRINKING
INDUSTRY
ATMOSPHERE
BIOTA
SOIL

FIG. I

Fig. 1

Table 1 illustrates how water is being used among the three major types of water uses and how each use is expected to grow by 2000 - 01 if our anticipated demands are realized

Water use has been considered in tow categories - non consumptive use that removes water from its natural courses and consumptive part of it. On a national basis, water for agricultural purposes is equal to 80 per cent of the total national use, that for domestic purposes is equal to 4 per cent and for industries it is only 18

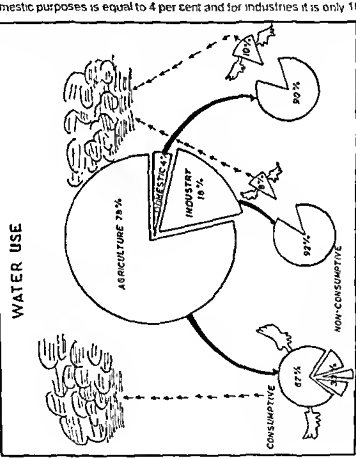

Fig 2

per cent. In agriculture sector it is 67 and 33 percent for consumptive and non consumptive use respectively. In industrial sector it is 8 and 92 per cent in consumptive and non consumptive use respectively. While it is 10 and 90 per cent in domestic sector for consumptive and non consumptive use respectively (Figure 7.2).

Several issues are strikingly evident One of the fact is that the largest uses are in agriculture. This is primarily in view of the agrarian economy of our country. Further, well before the turn of the century, on the current estimates of water availability and use, even with the withdrawal of all available resources, these will be short of agricultural demands (Chaturvedi, 1975).

Water requirements for drinking and sanitary purposes (Figure 3) is not large but it is extremely important from health, convenience and efficiency point of view. The requirement for clean water per person is about 2 7 litres per day. Thus the minimal amount of drinking water at the global level needed annually is about 5 billion cubic metre. In view

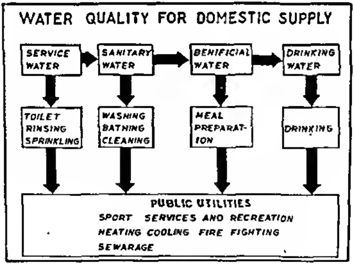

Fig 3 .

of our growing population, a colossal effort will be required to supply this basic need (Chaturvedi, 1975).

Industry of all kinds is a minor user of our water. The importance of water to meet industrial needs have been shown in Table 2, which indicate the amount of water needed to produce various amounts of major industrial commodities. Less than 10 per cent of the industrial plants, including power generation plants, account for 80 per cent of the total industrial intake. Excluding power plants - thermal and hydel both - the major users are paper industries, the cotton and jute industries, the sugar industry, fertilizer industry, steel plants, and refineries. Within the year 2000, it is expected to be only about 6 per cent of the potential.

Table 2. The estimated industrial water use (Chaturvedi, 1976).

Industry	Unit	Volume of water used (billion litres)
Dairy	1 litre of milk	6 - 10
Sugar	1 Kg sugar	15 - 40
Distillery	1 litre alcohol	20
Viscose rayon	1 Kg fibre	1600
Pulp and paper	1 Kg paper	270 - 450
Tannery	1 Kg hide	40 - 45
Integrated steel	1 Kg steel	20 -50
Fertilizer	1 Kg urea	6 - 8

Major Water Problems

In general, water problems are divided into three major categories. These categories are (a) problems of distribution throughout time and space, (b) problems of maintaining high water quality, and (c) problem of competing uses.

Problems of distribution : Poor distribution of water throughout the year causes problems which are quite different from those associated with general water supply. There is hardly a year that passes without serious floods or drought occurring some where in India

Drought of severe intensities, either continuous and long - lasting or interrupted by short wet-spells, lead to famine India, with its diverse climates and especially because of its strong dependence on

monsoonal rainfall experienced in the past, several famines of both widespread and local nature. Historical evidence points to no single drought that effected the country as a whole, but there are few exceptional years like 1877, 1899, 1918 and 1987 when a major portion of the country was affected by famine Further, north India and south India experienced drought quite independent of each other (Subramanyam and Shastry, 1971) Substantial areas of India have been facing drought condition once every 4 to 5 years. In drier areas such as Rajasthan, Gujarat and Andhra Pradesh drought occur once every 2 to 3 years. Western Rajasthan has been projected to face drought every 2.5 years (Table 3). In terms of geographical area, drought prone region represent about 19 per cent of the total area of the country and nearly 12 per cent of its population. Though there have been clear trend in the number of droughts per decade in the country as a whola, the number of drought year in specific regions have shown an alarming increase in the 1980's Whereas, tha period 1951 - 80 saw only two years of drought in Bihar plateau region, it has already suffered from drought for three years during 1981 - 86. Western Rajasthan has had drought like conditions for fiva of the past six years. Kerala, where once drought was unheard-off, has faced many drought years in the 1980's

Table 3. Periodicity of drought in different parts of India.

	Region	Periodicity
1	Assam	very rare, once in 50 years
2	West Bengal, Madhya Pradesh, Konkan, Andhra Pradesh, Karnataka, Maharashtra, Orissa, Bihar and Kerala	Once in 5 years
3	Eastern Utter Pradesh, South Kerala, Karnataka, Vidharbha	Once in 4 years
4	Eastern Rajasthan, Gujarat, Western Utter Pradesh, Rayalassema, Tamil Nadu, Kashmir	Once in 2 5 years
5	Western Rajasthan	Once in 2 5 years

Source - Report of task force on Integrated Rural Development, Planning Commission (India), 1973

Floods are more or less localised unlike droughts which are widespread (Dey, 1983). Regionwise, the most flooded area is that

drained by the rivers rising out of the Himalayas i.e., the entire north Indian plain, followed by the area drained by the rivers from the Chota Nagpur plateau i.e., from the Damodar to Mahanadi to the east of the Narmada in the west. The delta region of all south Indian rivers are also flooded. In the northern plains, floodability increases from west to east i.e., from Punjab to Assam. In four states - Utter Pradesh (largely eastern part), Bihar, Bengal and Assam the average affected area works out to about 42 lakh hectares annually. The Mahanadi and other deltas in Orissa flood nearly 5.3 lakh hectares, while the Tapti zone in Gujarat amount to about 12.3 lakh hectares (Table 4). The largest single mass of flooded area lies between the Gandak and the Tista, followed by the Brahmputra valley in Assam. The other flood prone are Punjab - Haryana, north eastern Rajasthan, the Narmada - Tapti region, Madhya Pradesh and Kerala.

Table 4. Occurrence of floods by states during 1953 - 1969 (Burman, 1977)

State	Total area affected annually (Lakh hectares)
Andhra Pradesh	3.50
Assam	9.10
Bihar	9.28
Delhi	0.17
Gujarat	8.16
Haryana	2.31
Himachal Pradesh	0.25
Jammu and Kashmir	0.91
Karnataka	0.05
Kerala	2.60
Madhya Pradesh	3.15
Manipur	0.10
Orissa	5.30
Punjab	0.99
Rajasthan	1.86
Tamil Nadu	0.56
Tripura	0.54
Uttar Pradesh	17.07

Problems of quality: The term "water quality" is intimately related to water pollution. Polluted water is that water which has more "negative" qualities than it has "positive" ones. Water quality refers to the physical, chemical, and biological characteristics of water. The physical characteristics include the temperature, clarity and similar qualities. Chemicat water characteristics include the presence of amount if present, of organic and inorganic substances in solution, and the way that these substances in solution are bounded or dispersed in water. Biological water characteristics include Identity, impact and organisms which are present in water. In simple words, polluted water, is water which has been abused, defied in some way, so that it is no longer fit for some use specially for drinking purpose.

The physical, chemical and biological characteristics of water are formed not only during its penetration through the atmosphere, soil and rocks but also during its contacts with the vegetation canopy and cultivation practices Waters from afforested areas are generally of good quality The replacement of forest polycultures by monocultures leads to an increase in acidity Water from afforested catchments can also become bacteriologically contaminated by wildlife, and particularly by birds. The pollution of water resources is a consequences of :

- Natural processes : erosion, volcanic activities, biological processes and human activities.
- Increasing erosion owing to deforestation, wrong cultivation practices and urbanization.
- Washing of agrochemicals from agricultural and silvicultural production.
- Accidents during the transport of fuel and other chemicals.
- Disposal of gaseous, liquid and solid wastes from industry, thermal and nuclear power generation, agriculture, dwelling areas etc.
- Subsequent leaching of wastes deposited on the surface, under the ground or in water.
- Infiltration of polluted water from or to ground water resources etc (Jermer, 1987)

We are facing the pollution caused by Municipal sewage, domestic *and industrial use of synthetic detergents, industrial wastes and* agrochemical runoff from the fields. (Figure 4). According to the survey carried out by several workers on selected stretches of some of

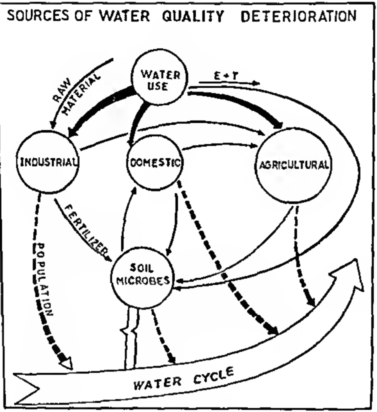
SOURCES OF WATER QUALITY DETERIORATION
WATER USE
RAW MATERIAL
E + T
INDUSTRIAL
DOMESTIC
AGRICULTURAL
FERTILIZER
POPULATION
SOIL MICROBES
WATER CYCLE

Fig 4

the important rivers, it has been observed that the water of most of our rivers in polluted (Agarwal, 1990). During the last few years much concern has developed over the continued deterioration of our lakes. This is mainly due to uncontrolled human activities which are responsible for the accelerated flow of materials from the terrestrial to the aquatic portion of the watershed (Vyas, et.al., 1982).

The ancient civilization has perceived the relations between water quality and human health and every effort was made to prevent the pollution of drinking water from contamination by human wastes. As long as, the human population was small and communities were scattered over large areas of land, the waste disposal created no problems. It was left to nature to dispose it by assimilation in the surrounding air and land. But with increasing population especially on the bank of water bodies, the spoiled water called sewage, was channelized to streams and rivers. At the beginning, this mode of disposal was considered to be quite suitable. But with rapid urbanization the natural waters have been polluted to such an extent that they have become unsuitable as sources of water supply (Alona, 1988). In towns of India, there are no facilities for efficient sewage disposal system. The magnitude of this problem even in big cities is epparent from the data given in Table 5.

Our natural water resources since decades have been subjected to different levels of ecological stress, by increasing pace of Industrialization in public and private sectors. The effluent is an inevitable consequence of industrial process (Singh, et al., 1985). The discharge of effluent into surface water has exceeded the assimilative capacity of the receiving streams at a number of paces (Jain and Agarwal, 1989), and is receiving greater dimensions day-by-day. So long as the pollutional stresses are within elastic limits, the ecological systems recover and tend to come to the original state. But once, the elastic limit is crossed, irrevocable stresses are set and the distorted ecological equilibrium does not return to the original condition observed under no stress condition (Shrotriya, 1984).

The nature and quantity of wastes differ from industry to industry, depending upon the nature of raw materials, processes used, products manufactured, and by-products recovered. Among all refining, mixing, blending, extraction, and manufacturing operations some wastes are produced (Table 6). Besides accidental spills, leakage and so forth, which may occur inspite of our best efforts and lead to grave consequences.

Table 5. Status of sewage disposal in some of the major cities in India (Raj, 1977)

City	Population	Present practice of disposal
Calcutta	75,00,000	Only a part of the city is sewered and primary treatment provided Part used for farming Balance to river in untreated condition
Bombay	55,00,000	Only 1 percent of the city sewage is treated partly with secondary treatment Balance goes untreated to the sea
Delhi	36,00,000	Three modern plants with primary treatment for 98 mgd and secondary treatment for 32 mgd
Madras	25,00,000	Part of sewage used for irrigation and part goes direct to the sea
Kanpur	15,00,000	*No sewage treatment plant. Part of 6 mgd used* for irrigation
Hyderabad	13,00,000	Screening and grit removal followed by irrigation.
Banagalore	12,50,000	No sewage treatment plant
Ahmedabad	12,50,000	Two modern sewage treatment plant.
Poona	7,50,000	
Nagpur	7,00,000	
Lucknow	6.75,000	
Agra	5 50,000	No treatment. Pumped for irrigation
Varanasi	5 00,000	
Madurai	4,50,000	
Allahabad	4,50,000	
Amritsar	4,00,000	
Indore	4,00,000	Secondary treatment plants
Jaipur	4,00,000	
Sholapur	3,50,000	
Kota	3 00,000	No treatment plant. Goes to river Chambal
Kolhapur	3 40 000	No treatment. Pumped for drinking

Table 6. Volume of waste water discharged from selected industrial operations in India (upto to year 1980).

Production manufactured	Waste water (m^3)
1 ton paper	50,000 - 1,00,000
1 ton straw board	20,000
1 ton steel	125 -155
1 ton oil	350 - 400
1 ton ammonia	2,000
1 ton urea	1,500
100 Kg hide	750
1000 metre cloth	33,000 - 99,000
1000 litre molasses	1,320
1000 litre milk	440 - 1,760

Perfection seems never to be reached, so at least some wastes are bound to be produced as long as industrial production continues.

Every segment of our society has been benefitted from the products of modern industry. However, when a useful chemical is produced, there is usually a residue or by-product which must be disposed off. Water pollution with chemicals is a direct result of the progress in the sense that a large ever growing list of new industrial chemicals are produced each year with accompanying possibility of new by-products and chemical wastes.

Chemical fertilizers, herbicides and pesticides have been identified as key inputs in present day agriculture. However, the increasing use of agrochemicals may pollute water through run-off from the treated areas and their subsequent accumulation in ground water and surface water reservoirs leading to the problem of eutrophication and deterioration of water quality (Attri, 1981).

The entry of pollutants in our water bodies sets-off a progressive series of physical, chemical and biological events in the down stream water The nature of the polluted water body is thus governed by the quality and quantity of polluting substances. Agricultural, domestic or

industrial effluent may adversely affect the natural water body by direct toxic action or indirectly through quantitative alternation in the character of water or that of stream/lake bed.

Competing Uses

The third major problem is the competing uses There are some uses of water such as navigation, recreation, hydroelectric power generation - in which water is used in such a way, which in no way alters the quality and quantity of water. As soon as the use is over, it can be used for any purpose including water supply, agriculture, industrial use etc. However, there are some uses like agricultural, domestic and industrial use of water which do modify either the *quantity or the quality of water and thus prevent its subsequent use.*

For the 1900 Mm^3 of water available per year for projected water use pattern for India (2000 AD) have been given in Table 7. It is clear from the data that irrigation (including for livestock) account for the largest share 79 6 per cent, followed by power 13 7 per cent, domestic 3 5 per cent, and industrial 3 2 per cent uses.

Table 7. Water use in India in 2000 AD. Available water 1900 million cubic metre per year (Chaudhuri, 1982)

Uses	In 1000 million m^3/year		
	Taken	Consumed	Returned
Irrigation and livestock	*896*	*783*	*86*
Power	150	5	145
Industry	35	10	25
Domestic	38	8	30
Total	*1092*	*806*	*286*

Irrigation water usually does not re-enter the streams from which it was taken. This water is taken up by the crops and is evaporated from the surface of the ground, or transpired from the plant surfaces. This means that irrigation water cannot be used for any other purpose, since it is returned to the atmosphere in vapour phase. Thus a downstream land owner would not have the full amount of water available to him that he is legally entitled to.

Inadequate water supply at critical times in the growth of crops may result into a colossal loss in their yield. The reverse is also to be avoided, an excessive water can also damage the crops to a great extent. Therefore, sufficient drainage of excess water from irrigated land is equally important for the satisfactory growth of crops, otherwise water logging may spoil the crops beyond repairs (Mahajan, 1985).

One of the obvious hazard of environmentally unsound irrigation projects is water logging which brings in salinity. Nearly 50 per cent of the water logged land is the result of surface flooding. Water logged area of West Bengal, Punjab and Haryana accounts around 60 per cent of the water logged areas of the country. Water logging and salinity have emerged is more pronounced in areas adjacent to the canals (Agarwal and Saxena, 1989).

The problem of supply of drinking water is important for any country. Most of our urban areas have drinking water supply. By March, 1981, 75 per cent of the urban population and 31 per cent of the rural population residing in 3121 towns and 5,76,926 villages has been provided with safe drinking water. Withdrawals for domestic and municipal use during 1968 - 69 were estimated at 24 - 98 billion litres per day.

In India, drinking water supply has assumed special significance because of the vast rural population flung apart is isolated end scattered villages numbering nearly 6 lakh. Most of the villages depend on wells for their water needs. In nearly a third of the villages, the wells are either inadequate or they go dry in summer and thus fail just at the time of the greatest need. In many drought stricken rural areas, the whole family have to set out in search of water in the early hours of dawn and return home by high noon with a few precious pots of water from wells or ponds after trekking 10 to 20 Km. in the scorching sun (Mafatlal, 1975). In many of our towns there is existence of the age old pipelines with low capacity water supply and even rusted and leakage condition.

In 1960 - 69 the total industrial withdrawal were estimated as 7.3 billion litres per day, of which 8.3 per cent was consumed within the industries, while the balance was returned to surface flow, primarily with varying degree of pollution. Demands for industrial water are expected to grow to about 151 billion litres per day by the year 2000.

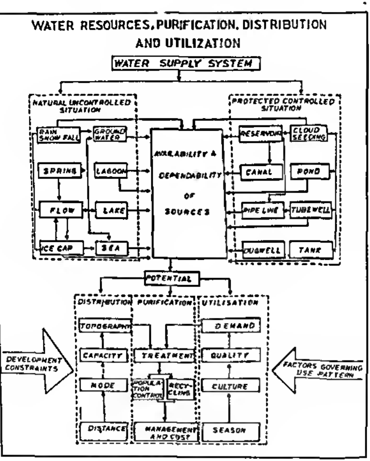
WATER RESOURCES, PURIFICATION, DISTRIBUTION AND UTILIZATION
WATER SUPPLY SYSTEM
NATURAL UNCONTROLLED SITUATION
PROTECTED CONTROLLED SITUATION
RAIN SNOW FALL
GROUND WATER
SPRING
LAGOON
FLOW
LAKE
ICE CAP
SEA
AVAILABILITY & DEPENDABILITY OF SOURCES
RESERVOIR
CLOUD SEEDING
CANAL
POND
PIPE LINE
TUBEWELL
DUGWELL
TANK
POTENTIAL
DISTRIBUTION
PURIFICATION
UTILISATION
TOPOGRAPHY
CAPACITY
NODE
DISTANCE
TREATMENT
POPULATION CONTROL
RECYCLING
MANAGEMENT AND COST
DEMAND
QUALITY
CULTURE
SEASON
DEVELOPMENT CONSTRAINTS
FACTORS GOVERNING USE PATTERN

FIG 5

Fig 5

Rain, snow, ice-caps, springs, rivers, lakes and sea are natural uncontrolled water resources. Where as cloud seeding, reservoirs, ponds, bore well, tube-well, tanks, canals, dug well and pipe lines are controlled water supply system (Figure 5). Water needs purification before its distribution and utilization. The purification, distribution and utilization suffers from development constraints and factors governing use pattern.

RESOLVING WATER PROBLEMS

Water requirements and water withdrawal usually exceed, or tend to exceed, the natural water requirements. In addition to this, effluent and excessive water consumption impair water quality, restricting its further utilization. The need to search for means of managing of water economy usually arises as a result of an actual or expected deterioration in water resources caused by pollution of an area in question or of a whole country. An adequate utilization of water resources and a proper control of the use of water are impossible without an adequate utilization of all available means, which are basically (a) legal, (b) institutional, (c) technical, (d) economic, and (e) personal and moral.

The legal, institutional, organizational, technical, economic and personal arrangements are criteria which are required to provide effective tools for the rational and integrated development, use and conservation of water resources at the national level are not very different from those required at the local level.

It is indispensable to use all the above tools for protection of human society before unuseful wastage, misuse and depreciation of water resources and before over- excessive water withdrawals, demands and arrangements threaten or have a negative impact on the environment, thereby resticting the future development or negatively influencing the living standard or life-style of the society concerned.

Special emphasis has to be laid on the conservation of the quantity of water from the sources to the points of consumption by making use of different techniques such as:

1. Efficient use - One of the most important conservation activity is the use of fresh water in such a way that we get the very most for our efforts without depleting it. Efforts should also be directed to increase the usability of low grade or polluted water. Sewage irrigation useful for raising valuable crops has long been known but application of

industrial wastes for crop raising or their hygienic disposal on land or in waterways is a comparatively new development.

2. Reuse - Water reuse has a special significance in mining, steel mills, pulp and paper mills,textile mills, oil refineries and similar industries where the resourca is scarce and the impurities can be separated by sedimentation, filtration, clarification, separation or any other suitable treatment. In many cases the cost of the treatment is modest as compared to the overall benefit. Reuse of water in effluent from towns needs to be given top priority in the allocation of resources. Trade effluent also need reuse to maintain water quality. Sometimes reuse is difficult as in the case of radioactive wastes water the cost of reuse may prove prohibitive as compared to the cost of providing water from a new source (Cahturvedi, 1982).

3. Waste water treatment - Our fresh water rivers, lakes and wells; and salty oceans had self correcting mechanisms, which used to check the excess of one thing over the other. Human Interference was also taken care by the nature, until the modern technology created a *situation where excessive exploitation and pollution caused as serious* threat to the very existence of life. Naturally, the common approach that " solution of pollution is dilution" is not adequate now Researchers are now looking for modem methods to treat waste water without the use of any reagents viz., ultra-sound-coagulation, magnetic treatment, electrophoresis, electric discharge etc (Mahida, 1983).

4. Efficient supply system - There is an urgent need to augment drinking water for urban and rural areas. This could be done by replacing rusted - chocked supply system existing for too long, and provision of emergency water supply system for the drought stricken rural areas. The modern methods of assured and controlled water supplies are still lacking in rural areas and call for management of our water resource.

5. Setting priorities - While setting priorities for water,we must all start from the premise that water, irrespective of where and how it is available, is the gift of nature and therefore a national asset No individual or family can be allowed to claim that a particular body of water belongs to that individual or family as a private property.

Whenever there is shortage of water, *first priority* should be given to provide drinking water for human beings and cattle. This use should have priority over any other use, irrespective of the consequences

Second *priority* should be given to agriculture, which is the mainstay of the Indian economy and the very life of the people of India. *Third priority* calls for allocation of any surplus available water to industries, however, the industries catering directly to the needs of the common people should be given preference over those which cater to their need somewhat indirectly (Mafatlal, 1975).

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8

WATER POLLUTION AND ENVIRONMENTAL STRATEGY

A Case Study of Udaipur Region

Dr. R.M. LODHA

INTRODUCTION

The area under study is located near the tropic of cancer between 24° 29' to 24° 45' north latitudes and 73° 30' to 74° east longitudes in Udaipur district of Southern Rajasthan, at a distance of 750 kms south of Delhi and 850 kms north of Bombay. The study area has been described into two geographical regions (1) Udaipur Basin – it is hill girdled area, inhabited by Udaipur city and 59 villages and (2) Environs - Area located outsida the basin. The industries outside the basin are located only in this part which is located east of Udaipur city. There are 51 villages in the environs. The population of the region is about 6.5 lakh. Out of it Udaipur city harbours 3.75 lakh population.

There are 360 large and medium scale and more than 3,000 are small and medium scale and cottage type of industrial units in end around Udaipur city. The region has one national level zinc industry, one H-acid producing plant, one cement plant, one pesticides, 12 fertilizer, one distillery, 200 marble, 100 soapstone, 20 synthetic and a few other units Besides, there are more than 500 brick kilns in and around city belching smoke and ash. Except marble units, the powder and smoke releasing industrial plants are located in the east of the city enroute the wind direction heralding pollutants in this saucer like structure of inhabited part, girdled by hillocks.

Most severe is the problem of water pollution in the region as the almost all units numbering 50 releasing chemicals and other pollutants ; *are located on the banks of river Ahar, spoiling ground water. The city* dwellers get their more than 70 per cent potable water supply from the polluted lakes. The water pollution of the area can be studied as under:

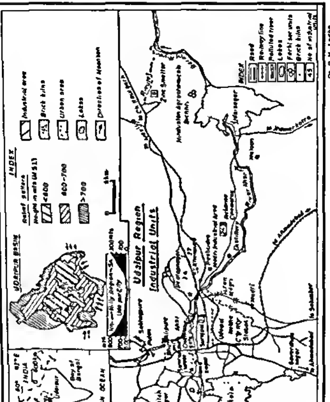

Fig 1

(i) Potable water pollution,

(ii) Industrial water pollution

POTABLE WATER POLLUTION

Most of the hotels along with 8,000 residential houses accommodating 35,000 population are located on the lake slopes releasing all sorts of dirt and drain water into the lake complex. Slopes have about 800 hanging latrines, 73 ghats used for bathing and washing, 50 drain spots, 19 hotels, 36 garbage spots and 118 open air defecation spots, maximum pollutants are being poured into the lakes. Nine out of each ten persons are suffering from water borne diseases here. As the river Ahar is flowing through the inhabited part of the city, accepts the drain water of tha whola city besides the huge amount ot industrial effluent

Thase lakas ara subjacted to organic contamination. Municipal sewarage lines open directly in the lakes and thus increasing tha bacterial and organic load. Tha Ghats situated on the banks of lakes ara traditionally used for bathing purpose and also to wash cloths. Hence large amount of detargents enter into these waterbodies every day, which increases phosphata content. Similarly increased commercial activity (e.g. Hotels, atc.) in the vicinity of lakes, has also addad considarably to water pollution. In tha catchmant area of Fatehsagar laka, chemical effluants from Synthetic Plants are discharged every day in a drain which carries water in Fatehsagar.

Results on water quality of lakes indicate that Picchola lake is highly Eutrophic. Indices of pollution and water quality parameters suggest that Picchola has higher nutrient budget (Eutrophication) which is mainly due to discharge ot organic wastes (43 lakh cubic metres annually) at 55 locations around this body. Excessive nutrient input has accelerated sedimentation thereby reducing water holding capacity of lakes. The supply lines are very old and damaged causing local contamination. Moreover, because of increased turbidity due to silting, the disinfection process is put on great stress

The water of these lakes is fully polluted. Consumption of contaminated water causes heavy morbidity. This is particularly true for children who suffer from bouts of diarrhaea frequently with fatal consequences. An analysis ot water-borne diseases in Udaipur city *revealed that typhoid fever, infective Hepatitis* and *Amoebiasis* are endemic in occurrence.

Strategies:

The lake water must not be used for drinking and as such new source of potable water supply be searched immediately.

INDUSTRIAL WATER POLLUTION

Location and siting of industrial activity has been viewed mostly with special reference to the regional location. In India till 1980 when a separate department for environment was established, the environmental degradation due to industries was not paid much attention. However, the attention was limited only to the incidence of pollution Even today after so much hue and cry regarding environmental deterioration, pollution is increasing unabatedly and to seek the permission to establish any industrial plant is only a matter of formalities including to seek the no objection certificate from the Pollution Control Boards. Such an attitude has brought us to a point of climax of pollution when 80 per cent of the total ground water has become polluted.

This chaos has been created only because of siting the industrial plants unmindfully. The worst part of it is that most of the plants have been located on the river banks mainly because of two personal advantages - first to get the water in abundance and second to dispose the industrial waste into the river. The second aspect has brought us to environmental catastrophe which is gradually being intensified At present because of releasing of effluents into the river, the sites have been fully polluted due to intravenous effect of toxicants on ground water and because of it, the polluted belts are prominent on the banks of the natural drainage. These are extensive on positive channel side, known as 'SAHAJA' (Vadose zone) having high water level with more number of wells with vast cultivable land, harbouring large size of population.

With geographical background a detailed study of 'Pollution Prone areas' has been conducted. The degree of pollution has been measured physico-chemically and examined geographically and geologically; in all using 13 parameters as per the situation of the spot. Thus 147 spots have been measured physico-chemically and 256 spots geologically. Among these 45 spots have been measured physico-chemically and geologically both.

Parameters :

Looking towards the nature of industries, spatial distribution of factories, volume of study, extent of the study area, expertise, nature of industrial landscapes of the study area, following parameters have been taken into consideration to analyse the environmental pollution in Udaipur region.

I. **Geographical** : *(i) Physical setting, (ii) Natural drainage*

II. **Geological** : (i) Strike of the rock, (ii) Dip of the rock, (iii) Joints and structure of the rock, (iv) Weathering horizon, (v) Nature of the rock and (vi) Distance from industrial effluent.

III **Physico-chemical** : (i) pH, (ii) Alkalinity, (iii) Dissolved oxygen, (iv) Fraa carbondioxide, (v) Electric conductivity

After synthesisation of these parameters on multi dimansional and interdisciplinary epproach, the study area has been divided into following 8 micro-areal units to study the pollution :

(i) Suman-Shruti Textile Area, (ii) Perfect Textile area, (iii) Inhabited city river area, (iv) Pesticides, (v) Hindustan Agro Chemical Area, (vi) Zinc Smelter - Daroli Lime Stona Area, (vii) Udaipur phosphates Fertilizer or UPF Area and (viii) Daroli-Vallabhnagar Area

Magnitude of Water Pollution :

pH : In this region pH has been found generally desirable. Out of 147 spots 107 spots have been found having neutral pH (7). At 26 spots water was found alkaline (> 7) and at 14 spots it was found acidic (< 7). The high alkalinity has been recorded in perfect thread area where out of 24 spots 17 have recorded high pH followed by Inhabited River Area. Suman-Shruti, Zinc Smelter etc. Alkalinity has been recorded high in Pesticides area also.

The average pH in the study area has been calculated 8, where as for Udaipur basin it has been recorded as 8.7 and for environs it has been recorded 7.8. The high pH in Udaipur basin is due to very high pH of perfect thread area (being 10.5) due to dyeing and processing units.

Alkalinity has been recorded as much as 352 PPM. Even the lowest alkalinity (44) has been recorded more than the average (28) of the study area as a whole. Inhabited river area is the second most polluted area recording pH 7.67 to 9.1 having average 8.39.

Table - 2 : Udaipur region - physico chemical values in average, minimum and maximum

S No	Areal Unit	PARAMETERS				
		pH	Conductivity	Free CO_2	Alkalinity	Dissolved oxygen
		DESIRABLE RANGE				
		7-8.50	100-350 (μ mhos)	1-15 (PPM)	10-150 (PPM)	5-7 (PPM)
Udaipur Basin						
1	Suman-Shruti Textile	7.88 (7.2-8.67)	323 (23-48)	78.00 (50-140)	53.60 (44-64)	2.33 (1.75-3)
2.	Perfect Thread	8.75 (7.4-10.57)	330 (25-63)	33.33 (0.54)	65.50 (44-352)	2.35 (1.75-3)
3	Inhabited	9.39 (7.57-9.1) -	3.11 (2.9-3.5)	30.75 (24-40)	3.93 (2.8-4.6)	
4	Pesticides	7.24 (5.25-8.15)	413	77.48 (2.9-3.6)	250.52 (24-40)	1.52 (2.8-4.6)
	Average	8.70	395	49.50	105.00	2.56
Environs						
5.	Zinc Smelter-Camp	7.56 (5.60-9.0)	481 (135-630)	37.00 (0-55)	178.30 (6-425)	1.62 (0.2-4.2)
6	Udaipur Phosphates	7.71 (5.71-8.45)	-	2.70 (2.4-3.2)	29.14 (23-32)	4.45 (3.5-5.2)
7	Dabok-Vallabhnagar	8.12 (7.8-8.56)	-	3.24 (2.9-3.5)	23.20 (23-34)	3.92 3.5-4.2)
	Average (Environ)	7.80	-	14.4	79	3.3
	Average (Region)	8.0	397	34.40	94	3.0

Note - Figures in bracket indicate minimum and maximum respectively

239u mhos for the river and 375 for the wells. The dissolved oxygen for the effluent has been recorded 2.48 PPM, for the river is 2.70 and in the wells it has been found lower and it is 2.48 again like that of the effluent. The alkalinity for the effluent has been recorded 82.31 PPM,

Table - 3 : Magnitude of water pollution No. of spots having less than (<), more than (>) and Desirable (=) values

S No	Areas	PARAMETERS												Total
		pH			Conductivity (μ mhos)	Free Carbondioxide (PPM)		Dissolved Oxygen (PPM)			Dissolved Oxygen (PPM)			
		7-8.5	<=	>	100-350	<=	>=	1-15	<	>=	5-7	<=	>=	
Udaipur Basin														
1	Suman-Shrub Textile	18	.	2	15	.	5	-	-	20	-	20	.	20
2.	Perfect Thread	7	-	17	20	.	4	-	3	21	-	24	.	24
3.	Inhabited River	4	.	4	5	.	3	8	.	.	.	8	.	08
4	Pesticides	23	8	.	10		21	-		31	.	31		
		52	8	23	50		33	8	3	72		83		83
Environs														
5	Zinc Smelter	48	4	2	16	-	35	1	2	49	-	52	-	52
6	Udaipur Phosphates	5	2	.	5	-	2	7	.	.	.	7	.	7
7.	Daroli	4	.	1	4	.	1	1	5	.	5	.	.	5
		55	6	3	25	-	39	3	2	49	-	64	.	64
Basin & Environs		107	14	26	75	-	72	21	5	121	-	147	.	147

it is 125.25 for the river and 135.80 for the group of wells. The river gets constantly some amount of water and wells do not get that much of water, are unable to dilute the chemicals. Less amount of Dissolved oxygen indicates the severity in the Region.

In the environs the sufferer is the Zinc Smelter Area as it records 1.62 PPM average having 0.2 as minimum and 4.2 as maximum. Daroli-Vallabhnagar (3.92 PPM) and UPF Khemli (4.46 PPM) record

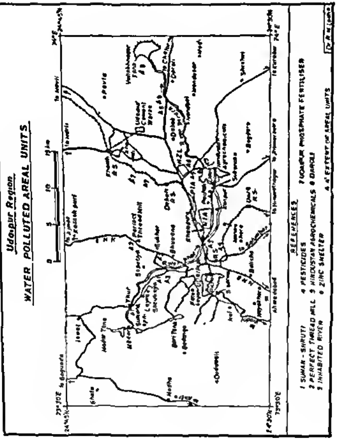
Udaipur Region
WATER POLLUTED AREAL UNITS
REFERENCES
1 SUMAN - SHRUTI
2 PERFECT THREAD MILL
3 INHABITED RIVER
4 PESTICIDES
5 HINDUSTAN AGROCHEMICALS
6 ZINC SHELTER
7 UDAIPUR PHOSPHATE FERTILISER
8 DAROLI
A A' EXTENT OF AREAL UNITS

Fig 2

3.5 as minimum and 4.2 PPM as maximum. All these indicate the bleak tuture ot the study region (Table 2 -column of Dissolved oxygen).

Spread of Polluted Water :

Suman-Shruti Area : The polluted water ot this area is spreading due to the north-aast, south-west joints towards east, south-east, polluting the Chikalwas. In the north, north-east and east ot the factory, the high values ot physico-chemical parameters are witnessing the worstening situation of the area. This area is polluted by the synthetic units i.e. Shruti Synthetics, Suman Synthetics, Shivrati Synthetics etc. Rock exposures are present in rivulet cutting only.

Area south of Brahmano Ka Gurha is mora polluted due to more weathered zone and being the location ot the Industry In the vicinity of this area. It is also because of the presence of weathered horizon, joints and bands in granitic gneisses.

Area located towards Thur village being in the north, will not be polluted as no indication of pollution has been shown by the existing fresh rocks. Hera due to higher topography, the surface drainaga is flowing towards south, south-east. However, there is a possibility ot further pollution towards Chikalawas due to presence of NE - SW joints.

Perfect Thread Area : This area is lying between Chota Bedla and Brahmano Ka Gurha is expected to be nonpolluted because of higher topography and becausa ot tha existence ot rock strata weak planar surfaces along N-S (Approx.) with little variation. The area north and south-west of Sapetia is likely to be polluted In future due to the existence ot more weathered rock and because ot presence of rock strata (N-S) weak planar surface. However towards extreme east ot Sapetia there are no chances of ground water contamination because ot higher topography to the river course comparatively and being surface water flow in west-east direction.

At present only river zone is polluted and there is a possibility ot its flow towards Shobhagpura village for which NW-SE sets joints and weather rocks are primarily responsible. Little chances ot pollution are there towards western side of river near Badgaon and Gogunda bifurcation ot road because of existing higher topography, the location ot surface water body being in the west, having north-south rock strata orientation. However, Bedla area may be possibly contaminated from ground water point ot view in future because ot the presence of more

weathered rocks and alongwith rocks cleavages baing NW-SE having NE-SW sets of joints.

Pesticides Area : In the pesticides area polluted water flow is based on nature of rock types, strike, dip, joints and their sets, relief pattern, topography, drainage pattern, river deposition (clay, Boulders etc.) soil cover thickness etc.

In the Bharat Petroleum area cleavages in the rocks, joint NW-SE, rock compositional changes and relief pattern etc. are playing their role in pollution spread. Khempura Area is under highest degree of pollution threat. Manwa Khera is right bank area of Ahar river.

Here direction of groundwater movement is NE. It is further supported by cleavage surfaces as well as joints. Secondary movement or spreading of pollutants ara due to NW-SE sets of joints. Here topography also favours this aggravation. Howavar, hera degrae of pollution is lesser than that of left bank area. Madri area is left bank area situated south of Madri village. Here maximum concantration of pollution is towards south of Madri becausa joints and their sets presant here are responsible for polluted watar spreading and it is furthar aupported by cleevages present here in the rocks. Phyllitic inter layered layars ara also favourable for this. Right bank of Ahar rivar, north of Kalarwas is area of thick river load deposition, where Relianca effluent rivulet is meating with Ahar river. Thus clayey-bouldary river deposition as well as thick soil cover are permitting pollutants for spreading in this area because of high porosity and permeability in this zone. Thus Kanpur village and its western area are being degraded day by day. If the supply of pollutants continues with the regular flow of effluent, it will pollute whole area of Kanpur, Bhoyon Ki Pancholi upto Sukha naka.

There is a thick clay deposition in Ahar river, especially south-east of Kanpur. Here phyllitic layers are also present with carbonaceous content, favouring speedy spread of pollution.

Hindustan Agro Chemicals - Bichhri :

Here polluted areas are there in the north-east and south east of the H-acid factory because of the following reasons -

(i) Ground slope is towards east. (ii) Drainage downstream is in eastward direction. (iii) North-South spreading of polluted water is due to more porous and permeable quartcitic conglomeratic sequence of

rocks. (iv) Area north-east of factory is polluted due to absence of NE-SW sets of joints as weak planar surfaces.

Western, north-western and even south-western sides of the factory covering bank areas of Berach river, starting from Udaisagar lake to Bichhri settlement will not be polluted because of higher topography in the west and the flow of polluted water is not possible upstream and strata are dipping towards east and north-east, obstructing the pollution.

Left bank side areas of Berach river which are non polluted at present, may come in the gnp of pollution because of : (i) Thick porous and permeable alluvium and more weathered rocks. (ii) Effluent water thrown by Bichhri fertilizer is draining towards east i e. towards Bichhri village. (iii) Surface flow towards east and in low lying area having alluvium deposition and weathered horizon hence ground percolation and finally groundwater contamination will taka place in futura

Zinc Smelter Daroli Area : In Gowla just near the Zinc smelter mostly pollution spreading is along the diagonal joints controlled by secondary flow directions having bandings in tha rocks Basides, nature of rocks is another important factor which has been considered here. Gowla village proper is polluted acutaly, it is spreading mora day by day. In Bichhri sector, the outlet drained watar of Udaisagar flows in tha form of Berach river; near Bhichhri, Zinc effluent carrying rivulet meets this fresh water and pollutes it, creating physico-chemical and geological implications. Here ground polluted water movement is controlled by banding in the rocks, and its flow is also governed by joints.

In Sihada sector flow is regularised by joints and weathering zone, occurring in the rocks. In Madhuphala area ground water flow is controlled by bandings and joints in this sector where as secondary flow is towards NE along the joints in this sector. In Dabok area polluted water movement is controlled by diagonal joint. Vertical joints developed are-east west and along these directions secondary water movement is eastward This shows that south of Dabok left bank area is acutely polluted. Around Dabok it is less but in near future there are more chances of pollution in this area. In Ordi sector water flow is towards south east hence pollution will be more in this direction and it will further be extended in near future. In Nandwel-Mandesar area, the flow is primarily controlled by joints and pollution will spread towards NE direction.

Khemli Fertilizer Area : At present groundwater contamination is not much. Possible area is towards Junawas, here is a possibility of spreading the pollution as more weathering of rocks in this area has been observed with the increase of surface effluent drainage. Near factory it will be more towards east along the surface drainage. However there is no chance of pollution towards Khemli Railway station as well as towards west of Khemli fertilizer plant i.e towards Khemli tank because of higher topography; direction of surface drainage being towards east.

Daroli - Vallabhanagar Area : *Due to rock strata/banding weak* planer surfaces (North-south, north-east) and also due to existence of NE - SW joints there will be pollution towards Maharaj Ki Kheri. Towards south of Daroli village pollution will not spread because of higher topography. However, there will be pollution towards Dhimra and Dhawa villages due to the existence of the development of joints in Granites.

Water Polluted Zones :

The main polluted zone is the river; Ahar upto Udaisagar and beyond Udaisagar it is known Berach, works as backbone. The impact of this *polluted channel is apparent on the wells connected with it,* located on both the banks. The degree of severity of pollution decreases with the increasing distance on both the banks; left and right. The pollution zones run parallel to this river channel from Thur to Vallabhanagar. The polluted areas of the region has been divided into three zones : 1.Severely polluted zone. 2. Moderately polluted zone and 3. Lightly polluted zone.

(i) Severely polluted zone : *It includes the river channel from Thur* to Vallabhanagar tank. The river banks of both the sides having wider strip in the right are the **Suman** - Shruti, Pesticides, Hindustan Agrochemical Area, Zinc Smelter, Daroli areas. The Southern strip (4 km.) located on the right bank is wider than the northern strip (2 km) of the left bank. Right bank being the bank of vadose zone i e. 'Sahja' has high water table harbouring more number of wells. The left bank of the channel is the dark zone of having very low water table. The polluted belt is also in the form of a narrow strip. Thus wells of Suman-Shruti (20), Pesticides (70), Hindustan Agro chemicals (65), Zinc Smelter (55) numbering 210, have been fully polluted. Worst is the situation of the wells of Hindustan Agro Chemicals are, having dark brown to light brown colour of the water. *As one proceeds away from* the banks, the degree of intensity of pollution decreases.

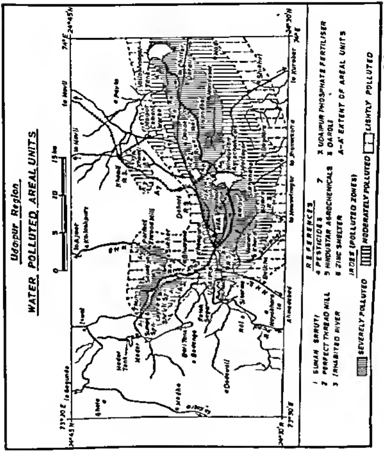
Udaipur Region
WATER POLLUTED AREAL UNITS
REFERENCES
4 PESTICIDES
5 HINDUSTAN AGROCHEMICALS
6 ZINC SMELTER
7 UDAIPUR PHOSPHATE FERTILISER
A-A' EXTENT OF AREAL UNITS
SEVERELY POLLUTED
MODERATELY POLLUTED
LIGHTLY POLLUTED

Fig 3

(II) Moderately polluted zone : The inhabited river area, UPF Khemli, Daroli, Vallabhanagar strip. On an average the strip beyond 2 km distance (2 to 3 km) from river in the north and beyond 4 km distance (4 to 6 km) from the river in the south moderately polluted zone starts running parallel to the river channel on both the sides almost. Though looking towards the degree of severity at 'Suka Naka' Udaisagar must be considered in the zone of severity but due to the existence of huge quantity of water in the lake, the intensity of pollution is minimised through dilution on pollutants into the water.

(III)Lightly polluted zone : The zone beyond the moderate zone is zone of least pollutation. It is 6 to 8 kms on the right bank and between 3 to 4 km on the left bank.

Looking towards the present situation even with the presence of existing Industrial plants, the degree of pollution will increase here by intensifying the pollution. The intensity and extent of all the three zones will increase in near future taking more wells into grip, here by polluting more agricultural land and wells used for irrigation and potable water. .

The Impact of Pollution in the Region :

Effects on Human beings : (i) The time taken for digestion of food is longer (ii) Burning sensation in the stomach (iii) More of stomach aches (iv) Feeling of nausea (v) Wells near the river are more polluted and in course of bathing a white layer is deposited on the skin. (vi) The skin too gets dry and hard. (vii) Cracking and chapping of skin while irrigating their fields.

Effects on Land : The residuals from the plant sink down into the earth and are later on brought back on the surface, as a result of irrigation. The affected area than experiences the problems like : (i)The land is gradually hardens. (ii) Due to it the problem is faced in ploughing this hardended land. (iii) The productivity deteriorates (iv) There is a change in the taste of sugar cane.

After causing havoc in a number of villages, the river Berach falls into Vallabhanagar Tank. Here it partially affects the irrigated area. The ground water table has also been polluted hence the well water too does not remain potable.

Effects on animals : (i) Animals avoid drinking this water. (ii)Animals are taken to far distance for drinking water. (iii) If the animals sit in this water for long, their skin starts peeling off. (iv) Due to lack in growth of

vegetation, availability of fodder too has fallen, hence the animals do not get proper nourishment and food. This leads to weakening of the animals. (v) Fall in the quantity of milk given by milching animals has also been noticed.

Effects on edibles : Due to the polluted water, certain problems are faced while cooking. Those are : (i) Dal takes longer time in cooking, (ii) Milk gets sour due to which tea can't be prepared, (iii) Due to the polluted well in the villages, potable water is either brought from quite a distance or is supplied through pipe.

STRATEGIES

The above analysis leads to the conclusion that Udaipur region is highly sensitive environmentally. If checked from adverse circumstances deteriorating the ecosystem, it can be converted into heaven having a beautiful valley with bountiful resources having a rich and unpolluted vadose zone girdled either by lustering lakes or by densely forested hills inviting saturated monsoon.

In case the prevailing of locating and siting of industrial plants continues along with releasing the industrial effluents into the natural drainage and rate of fast degrading forests continues, this basin will be converted into hell within 250 years of its life span. The shadows of such adverse incidences are apparent and whole area will be converted into a dust bowl shaping the valley into a Ghost micro region.

On the basis of above discussion certain strategies can be developed to avert the water pollution in the area under study. On the basis of anti pollution measures based on natural as well as man made efforts from the siting of industrial plants point of view, areas can be divided into which industrial locations should be : (a) Strictly prohibited; (b) Permitted with anti pollution measures and ; (c) Permitted unobstructed.

(a) Areas strictly prohibited for the industrial location are : (i) kutcha land and porous structure of the rock (ii) slope of the ground specially the steep slope. (iii) the natural drainage (iv) vadose zone or 'Shaja' must not have Granitic rock structure of horizontal exposure, saucer like and alike structures.

(b) Permitted with antipollution measures : (i) providing impervious construction so that water does not percolate into the surface of the ground 4 to 8 km on the right bank of the rivulet; 2 to 4 km on the

left bank of the rivulet Industrial plant can be located. (ii) Establishing effluent treatment plant (E.T.P.) (iii) Establishing recycling process (iv) Re-use of the effluent in the plant itself or in other plant without releasing on the open ground.

(c)Permitted unobstructed : (i) Areas, located between piedmont and river/rivulet banks (ii) impervious rock structure. (iii) Areas away from the inhibited part.

To stop the further deterioration of Udaipur region and to maintain its beauty and rather to enhance it certain precautionary measures are to be undertaken. These are three dimensional : (i) The establishment of non polluting Industries and the shifting and even removal of certain existing industrial units ; (ii) Proper selection of sites of the plants; (iii) Awareness.

(i) The establishment of non polluting industries and the shifting and even removal of certain existing industriel units : In the area like Udaipur besin only non water polluting industrial units be established. The hilly ereas are quite sensitive from water pollution points of view, firstly because of slope, leading to the flow of water to low lying ereas, secondly because of being source of origin of eny rivulet the flow starts and in case any effluent is poured into it, it spoils whole dreinage to which the polluted water meets. Besides, the vadoze zone becomes polluted leading to ground water contamination.

Fertilizers, synthetic, distillery and Pesticides units pollute the water severely; need shifting However, while establishing these units outside the basin, the precautionary measures like storage of effluents, the provision of ETP and complete ban on releasing even treated water into natural drainage be imposed, what to say for effluents.

(ii)Proper selection of sites of the plants : Geologically the site for the factory must be carefully selected. The immediate land must be quite hard and if it is of Igneous rock, it will definitely able to stand with the jerks and vibrations, caused due to running machines. The immediate site must be non-porous to the effluent so that it may not be able to percolate into the surface of the earth to pollute the groundwater. The site having cracks and joints be avoided. The dip of the rock and weathering horizons be checked carefully.

Before doing all these the primary efforts must be not to release even a drop of effluent out of the factory, while storing it into the full-proof non-porous scientifically constructed ditches.

This effluent be treated at the factory level to separate solids and liquids and ancillary industries based on them be developed. For all such provisions, selection of site plays an important role. In this regard the banks of the river be avoided. Piedmont site always be avoided. Due to simply choosing wrong site by the Hindustan Agro Chemicals the single plant, the silver chemicals triggered the tragedy in Bichhri region in 1988-89 by killing more than one thousand animals, destroying the thousands of trees, polluting the potable water, leaving about 8500 people into a suffocative atmosphere to spend the painful life, spoiling more than 500 hectares of land, polluting about 70 wells due to this H-acid producing plant, converting their water from dark brown to light brown colour. This piedmont location baing on higher ground from the fertile valley with rich vadosa zone (Sahja) contaminated the ground water severely.

(III) Awareness : To check the pollution awareness is tha must. Onca awareness about the establishment, siting and pollution is thera, nothing more than it, is needed. The industrial plants are poorly located in this area from location and siting point of view. Tha consideration of location of industries has been regarded from the 'laast cost' point of view and as such the environmental concerns were important, money spent on the improvement of environment is considered a loss of profit. The gain is gathered by an individual, and loss is being poured on the public in the form of a deterioration of its quality of life. The whole problem can be solved through awareness. By environmental awareness action may be initiated towards its improvement by eliminating faulty human interference and cultivating environmental perception next to it. Environmental preservation also can be taken up effectively through systematic planning.

To cultivate awareness, three dimensional strategy is to be developed i.e at the levels of Government, industrialists and public. Government to day even after almost half of the century of freedom and in spite of lot of scientific development, no scientific and technical tests conducts before allotting the plots for any industrial plant. Now for last two years after the revision of the environmental laws in 1991 physibility report has to be submitted before getting the license for the plant. Even after this law, geological and geographical considerations are not being paid any attention. But with the occurrence of calamities

the awareness at the level of government is increasing and laws are being modified to check the pollution. In the year 1988 government constituted a committee to examina Bichhn pollution incidence in which the author was also ona of the three members. On its recommendation the plant was closed immediately. Offica of the pollution control Board was opened in 1991 which conducted also the brick kiln survey and suggested alternate sites away from the city. Also attempted a futile effort to install three air pollution measuring instruments. Besides, investigation was initiated to enquire the pollution due to UPF Khemli and Hindustan Agro Chemicals. Awareness at the level of industrialists is not at all and to spent on the anti pollution measures is considered a personal economic loss. Sometimes they become quita sour to the people who suggest the anti pollution maasures

Public equally is to be made awara about the environmental pollution. Tha wells of Suman-Shruti and Perfect Textile, Pesticides, Hindustan Agro Chemicals and Zinc Smelter areas hava been very badly polluted end in near futura more ereas are to be thraatened Above ell, tha responsibility of the pollution lies on the government es it approves the schemes, it earns the name due to industrial development. Before ellotting the industrial licences proper formelities be practically examined to avert the untoward situation.

In case all tha dimensions fail to avert the pollution ; at least following natural laws must be followed. Thair application does not cost any thing except to apply common sense. While locating any industrial plant : (i) Avoid the hilt habitation ; (ii) Avoid disposal of effluents into the natural flow of water ; (iii) Avoid porous rocks and rock structure, where it would cause infiltrated polluted water from moving downward to contaminate of the region.

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9

ENVIRONMENTAL IMPACTS OF CHANNELIZATION OF RIVER YAMUNA IN DELHI

B.S.SOKHI

INTRODUCTION

Evar sinca human beings have congregated together in towns and cities, they hava continuously changed their surroundings depending primarily upon the need for shelter in the pravailing climate. Tha inevitable result of any such attempt to creata an area of controlled environment is an inadvertent and often subtla alteration to tha local microclimate. River channalization is ona such attempt. River channelization is not a new activity, it has increased over tha years with population growth and development of flood plains for habitation, industry and agriculture. Channelization is a response to the needs of a developing social and economic structure to the problems created by occupance of the flood plain.

PURPOSES OF RIVER CHANNELIZATION

River channelization may be defined according to the reasons for which it is undertaken . Most extensive purposes of river channelization are -

a. Urban Flooding

b. Urban Development

c. Drainage of agricultural land

d. Erosion control for protection of urban land, agriculture, roads and bridges.

River channelization to contain urban flood water may be relatively successful in a hydraulic context, but the last couple of decades have seen a growing awareness of the adverse impact that

may also be manifested in reaches downstream of the engineenng scheme, broadening the area of ecological disturbance.

Where channelization in upland river results in a simple trapezoidal shaped channel, the immediate effect is to produce of channel devoid of typical pool-riffle sequences and without vegetation and in-stream cover may be of considerable importance to many organisms. In a natural system, channel width and depth are also adjusted to flow regime, probably to bankfull discharge and its recurrence interval and any destruction of this equilibrium may lead to the erosion of bed and bank material, with elevated concentrations of suspended material in the water and subsequent sedimentation In particular, the removal of backsides vegetation and decreased soil stability are likely to lead to increased sediment loads to rivers. The removal of shading beckside vegetation, for access by machinery or in order to reduce frictional effects, may lead to in-stream temperature changes,as can changes in water depth. Since most streams receive their chief source of energy in the form of organic matter, often as tree leaves and terrestrial invertebrates associated with tree, losses of backside vegetation may also substantially reduce energy flow in the equatic system

IMPACT OF CHANNELIZATION ON IN-STREAM ECOLOGY

Reduction in stream length by channel straightening lead to total biomass reduction In general, fish population is severely affected by channelization of natural supporting higher densities, greater biomass and more species and any recovery is usually slow. Such effects are usually attributed to losses of in-stream cover, less space, elimination of riffle-pool sequence, decreased habitat diversity, unstable environment resulting from fluctuating water levels and shifting sub-strata and greater fluctuations of water temperature. The response of macro-invertebrates to channelization is variable. However, collections are generally restricted to a specific habitat or greater cognizance should be taken of the charactenstic fauna of the normal range of habitats (e.g. riffles, pools, vegetation) and changes in the distribution of such habitats following channelization

Aquatic plants are important to the general ecology of rivers since they provide a source of energy, contribute to the cycling of nutrients and organic matters and provide an additional sub-strata for micro and macro-organisms. River vegetation is determined by the physical and chemical characteristics of channel and alterations of depth, flow and

the composition of the substratum are likely to lead to changes in plant communities.

IMPACT OF CHANNELIZATION ON BACKSIDE ECOLOGY

Channelization often devastates backside trees and ground cover resulting in removal of habitat of many kinds of bank side wild-life. Channelization has a direct impact on riverine birds and where such works are related to land drainage schemes changes in water status of the catchment and subsequent land use substantially reduce area available to breeding wetland birds. Backside vegetation plays a particular important role in regulating stream temperature. The increase in temperature both decreases the capacity of the stream to hold oxygen and causes changes in the structure of aquatic communities as soecies with low temperature optima are unable to survive

Since plant nutrients tend to attach themselves to sedimant particles, the increase in nutrient loading that has been found to accompany construction activities is also mitigated the rate at which such suspended solids are converted to soluble forms of nutrients also incraases markedly with temperature, so that the shade provided by backside vegetation reduces their utilisation as well as thelr availability. In addition, the removal of near-stream vegetation particularly in the headwaters of river systems, results in a loss of energy inputs that disrupts aquatic food web and reduces the production of both invertebrates and fishes.

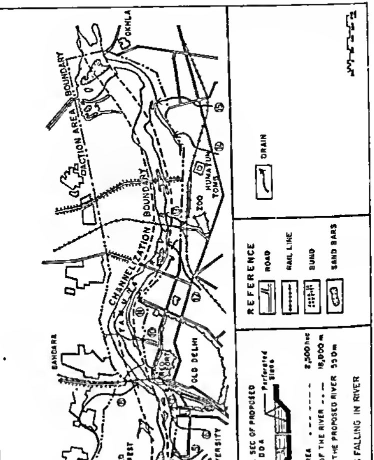
MORPHOLOGICAL IMPACT DOWNSTREAM OF CHANNELIZATION WORKS

Repercussions of any man-induced changes at any given location can be transmitted over a wide area, especially in the down stream direction. Geomorphological research during the last couple of decades has revealed a series of impacts upon river channel morphology which can persist for very considerable distances below. No attention has been given to the morphological consequences which occur in the natural river channel beyond the immediate downstream *limit of the channelization works.*

The downstream consequences can be divided into two phases:

a. Impacts associated with construction, and

b. Impacts those which occur following completion of the scheme



OKHLA
ACTION AREA BOUNDARY
CHANNELIZATION BOUNDARY
YAMUNA
HUMAYUN TOMB
ZOO
SANGAM
RED FORT
OLD DELHI
PROTECTED FOREST
DELHI UNIVERSITY
N
REFERENCE
ROAD
RAIL LINE
BUND
SAND BARS
DRAIN
CONCEPTUAL SEC OF PROPOSED CHANNEL BY DDA
Perforated Slabs
ACTION AREA 2,500 hec
LENGTH OF THE RIVER 15,000 m
WIDTH OF THE PROPOSED RIVER 550 m
FIG.3 STORM DRAINS FALLING IN RIVER

Fig 3

1. Length of Channel = 18 Km. (between Wazirabad barrage and Okhla Barrage)
2. Width of channel = 550 mts.
3. Depth of channel = 12 mts. (Below existing river bed)
4. An area of about 3000 ha. would become available for development.

FAUNA OF RIVER YAMUNA

The fauna in the river consists of macro fauna and zooplankton. The macro fauna is constituted by snakes, tortoises, fishes and birds. There are 57 species of fishes in tha river Yamuna

River attracts a large number of birds near Nizamuddin bridge and Okhla march, both local and migratory birds. Near Humayun's Tomb a larga number of water-fowl can be seen. Tha sand banks are the nestling places for Sandlarks, Little Wingad plover, Great stona plover. Former colonies of the Little Terns, Skimmers end Little Pranticolads have been driven away by melon cultivators. Vertical banks of the nvers are used by Bole Nesters like Bank Mayna, King Fisher and Sand Martings.

Tha season of birds migration is from October to March. During this time, the birds from colder region migrate to sunny araas and require various kinds of resting places - on trees, in bushes, in sands etc. Okhla march provides a good environment for these birds. Water being stagnant and rich in humus contain lot of aquatic vegetation providing food for fishes which in turn habitats birds.

FLORA OF RIVER YAMUNA

Vegetation is one of the most important ecological determinants. It is an essential nutrient and quantity of it is a vital deciding factor for presence and thriving of a particular plant. In the Yamuna plains the vegetation types can be basically categorised into Hydrophytes. (aquatic) and Terrestrial (Fig. 9.4 & Table 1).

Hydrophytes are plants in which tha roots, when present, and a part or whole of the shoot are submerged in water. These aquatic plants fall into three categories viz.

i. Submerged Plants

ii. Floating Plants

iii. Amphibious Plants

Table 1 : Flora along River Yamuna in Channelization zone

FLORA

AQUATIC		TERRESTRIAL		
MACRO FLORA	PHYTOPLANKTON	EXOTIC	INDIGENOUS	
Ecchornia Water hyacinth seen floating through out the stretch' Sewage enhances Ammonia & Phosphate in water and thereby increases unwanted algae growth.	Phytoplanktons like Cyanophytha, Oscillatoria, Chlamydomonas, Scenedesmus and Diatoms. Filter clogging algae like Chroococus, Cymbella, Closterium are present.	Plant for - Road - Recreational areas - Protected Forest - Crop Cultivation	Lower Canopy Vegetation - Saccharum - Zizyphus Numelaria	Upper Canopy Vegetation -Acacia Nilotica -Mitrogynan pervifolia -Dalbergia sisso -Zizuphus Jujuba
Amphibious Plants. 1. Phragmites 2. Arundo 3. Typha 4. Zizania 5. Cyperus	Surface Water algae like Nodularia, Coelastrium, Fragilaria are present.			

FACTORS INFLUENCING AQUATIC VEGETATION

1. WATER QUALITY (NUTRIENTS)
2. SOIL SUSSTRATA
3. WIDTH OF CHANNEL
4. DEPTH OF CHANNEL
5. WATER FLOW (VELOCITY)
6. TURBIDITY

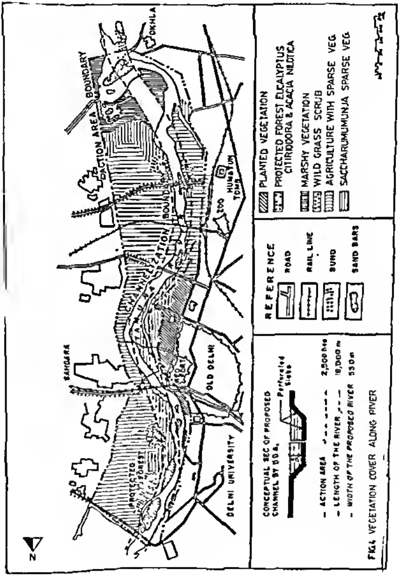

OKHLA
ACTION AREA BOUNDARY
CHANNELIZATION BOUNDARY
HUMAYUN TOMB
ZOO
SAHDARA
RED FORT
OLD DELHI
PROTECTED FOREST
DELHI UNIVERSITY
N
PLANTED VEGETATION
PROTECTED FOREST EUCALYPTUS CITRIODORA & ACACIA NILOTICA
MARSHY VEGETATION
WILD GRASS SCRUB
AGRICULTURE WITH SPARSE VEG.
SACCHARUMMUNJA SPARSE VEG.
REFERENCE
ROAD
RAIL LINE
BUND
SAND BARS
CONCEPTUAL SEC OF PROPOSED CHANNEL BY D.D.A.
Perforated Slabs
– ACTION AREA 2,500 ha
– LENGTH OF THE RIVER 16,000 m
– WIDTH OF THE PROPOSED RIVER 550 m
FIG.4 VEGETATION COVER ALONG RIVER

Fig 4

The stationary and fast running conditions only influence plant growth profoundly. In fast running conditions only such form of aquatic plants serves as food, shade or protection for fish, or they support algae or small animals which are directly or indirectly food for game fish. They also form habitats for deposition of eggs aquatic life by oxygenating the water. Aquatic plants are useful to various kinds of birds (e.g. marsh birds), wild fowl, shore birds, upland games birds and *mammals*.

In the category of submerged plants and floating plants the flora in the river consists of macro flora and phytoplankton. The macroflora in the river is constituted by Eicchornia water hyacinth. It is predominantly seen floating in the Okhla barrage area, old Yamuna bridge area due to stagnation of water and along the banks of the river for most of its course

The rooted hydrophytes which remain submerged are rastricted to shallow regions where sufficient light is available. These plants exist only et Okhla marshy area. The submerged hydrophytes ere:

a. Plants with long stem covered with leaves and roots arising from nodes, for example, Hydrilla, Largarosiphon, Patomogeton, Najas etc.

b Tuberous stem with coulina leaves, for example, Vallisnaris, eponogrton etc. The leaves are ribben shaped, thin and filmy.

c. The rooted hydrophytes with floating laaves. This type is elso restricted to marshy areas at Okhla. The leaves emerge up end keep floating leaves on long flexible petolle, for example, Hymphara stellator, Nelmnbouncrfera Anonogton

Phyto planktons: Total number of organisms identified by Botany Department of Delhi University in the river are 327 at two stations at Wazirabad and Okhla The three principal types of algae and their percentage presence are as follows:

	Wazirabad	*Okhla*
Cyanophyta	43%	11%
Chlorophyta	22%	04%
Bacillarophyta	32%	05%

Other phytoplankton present are oscillatoria, chlamy domonas, scenadismis and Diatoms

Amphibious Plants: Plants of this group inhabit shallow waters. Their roots, part of stem and often a portion of foliage are under water, but a portion and often most of the shoot is aerial. These plants are in abundance at Okhla marshy land and in patches at Nizamuddin bridge. Polygonum is important to wild fowl, upland games birds, shore birds and attractive to wild fowl.

Typha's stalks and roots are important food for muskarta and attract marsh birds, wild fowl and song birds. It is spawning ground for sunfish and serves as shelter for young fish Some birds like to build their rests on Thphas Zizania is among the most valuable grasses as its grains are eaten birds.

Terrestrial Vegetation : Most of the terrestrial vegetation is under management of cultivation and afforestation and hence very little of indigenous plants species are left.

Channelization of river and development along the river would disturb these natural conditions - like habitats, food chain etc. After channelization and subsequent urban development would Incraasa the human activities, would be counter productive for the existence of fauna especially for migrating birds and for flora of this stretch of the river.

CONCLUSIONS ANO RECOMMENDATIONS

In tha past river channelization works have been carried out with little regard for the environment, but the situation has changed considerably in the recent past and now there should be a collaboration between Ecologists and Engineers. The following points are extremely important to the success of any channelization project:

Firstly, there must be full and detailed collaboration in the design and planning stages. This includes fisheries, biology and conservation aspects and necessitates good communication procedures between the different functions.

Secondly, there is a variety of modifications of features that can be incorporated into the engineering design that will ameliorate the effects on wildlife but will not jeopardize the carrying capacity of the channel. These modifications include retention or creation of pool/riffle regimes, small weir, asymmetric banks, two-stages channels, introduction of artificial substrata and tree planting and landscaping. It is much more useful that these modifications be incorporated as the work progress rather than introduced later as remedial measures.

Thirdly, the cost involved for environmental work and studies should be accurately workedout abd financial provisions allowed for it. It is not satisfactory just to designate a nominal small percentage of total costs to the environment.

Fourthly, it is very important that Ecologists are present when the engineering work is carried out.

Finally, the impacts of channelization schemes should be monitored continuously.

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10

THE BIODIVERSITY

Dr. R.K. Srivastava

Over exploitation and over utilization of natural resources in the name of development and civilization, over population of man and dwindling population of trees and animals, shrinking forests and extension of concrete jungles, industrialization, urbanisation and motorization, tall towers belching out poisonous gases and dust in the atmosphere and draining filth and harmful minerals in the rivers and streams as effluent, production and piling of deadly nuclear weapons, boosting of food production by chemical fertilizers and toxic pesticides, all these and akin activities of man have created an imbalance in the natural environment, pollution hazards and threat to the extinction of even man

Complex beyond understanding and valuable beyond measure, biological diversity is the total variety of life on earth. No one knows, even to the nearest order magnitude, how many life-forms humanity shares the planet with; roughly 1.4 million species have been identified, but scientists now believe that total number is between 10 million to 80 million. Most of these are small animals, such as insects and mollusk, in little explored environments such as the tropical forest Canopy or ocean floor. But nature retains mystery in familiar places as well.

Despite the vast gaps in the knowledge, it is clear that biodiversity - the ecosystem, species and genes together make life on earth both pleasant and possible, is collapsing at nothing less than mind boggling rates. Difficult as it is to accept, mass extinction has already begun and the world is irrevocably committed to many further losses. Harvard biologist Edward O. Wilson estimates that at a minimum, 50,000 invertebrates species per year - nearly 140 each day; are condemned to extinction by the destruction of their tropical rain forest habitat. Large creatures as well as small are vanishing, deforestation condemns at least one species of bird mammal or plant to extinction daily. Wilson (1992).

Moreover, biological impoverishment is occurring all over the globe. Ecosystems with fewer species than rain forests have, such as island and fresh water lakes, are probably losing even greater proportion of their varied life forms. Genetic varieties within species and entire natural communities are also disappearing, likely at rates greater than the extinction of species themselves

Why should disappearing beetles, plants, birds reptile concern us ? To biologists, and to many other, the question hardly needs any explanation. A species is the unique and irreplaceable product of millions of years of evolution, a thing of study for scientific study, for its beauty and for itself, for many people however, more compelling reason to conserve biological diversity is likely to the pure self interest, like every species, ours is intimately dependent or others for its well-being.

Time aftertime, creatures thought useless or harmful are found to play crucial roles in natural systems. Predators driven to extinction no longer keep populations of rodents or insects in check; earthworms or termites killed by pesticides will no longer aerate soils, mangrove cut for firewood no longer protect the coast line from erosion. Diversity is of fundamental importance to all ecosystems and to all economies

For the few years, the subject of conservation of biological diversity has attracted considerable attention at the national and global level. Conservation has been defined as the management of resources for the benefit of all life, including human, of the biosphere, so that sustainable benefit may be derived by the present, while the potential maintained to meet the needs and aspirations of the future generations. It is, therefore, a dynamic and continuing concept and not for maintaining status quo, i.e. put a fence around an area or collect a few seeds for storage. Furthermore, our actions have to be such that do not impair in any way, the needs of the future generations who are not represented in any of the present day form. Conservation of biological resources in space and time, has inbuilt elements of evolutionary genetics. If we agree on this approach, most of the so called conservation work is at best preservation, which may be alright as a "first-aid approach", but our objectives has to be conservation in space and time. Biological diversity is the richness of species, i.e., number of species in a community of living systems. There are four states-individuals, populations (inter breeding individuals of a species), Communities(Combination of population of different species,

occupying the same habitat) and ecosystems (interacting group of communities in a climatic region).

Diversity characterizes most biological resources and is the result of three cardinal processes (mutations, recombination and natural selection) responsible for organic evolution. These processes are important for diversity, leading to organic evolution in nature, as also under the influence of mankind. Today there are roughly 5-10 million species of biota (IUCN 1980) on the planet, which are the result of 3 billion years of evolution. The present day biota represents hardly one percent of the total that have existed on this planet

The major selective factor has been the environment, precisely the changing environment, the ice age, receding glaciers followed by warm periods and other cataclysmic changes like comets striking the earth or volcanic eruptions, leading to the rise of a thick envelope of dust, blackening of tha atmosphere and the black out of sun for long periods,resulting in changa of climate and even the spread of diseases. Such changes have led to the extinction of the old and origin and evolution of new species.

Essentially, extinction and evolution of species have gona on side by sida and are a part of the overall evolutionary processes. Why than, are wa worried about the present wave of extinctions of our biota ? The reason is that the present wave is entirely due to action of mankind and due to escalating demand for resources leading to serious ecodegradation and not due to natural action.

India has a land mass of 329 million hectares with a tremendous ecogeographic diversity. Almost all types of habitats present in the world are found in India. There are two biogeographical realms in India and it is the confluence of floras and faunas of African, Mediterranean, European, Sino Japanese and Malayan regions, yet there is a good deal of endemism (about 61% in flowering plants). Because of presence of diverse type of climate and habitat, India has contributed 152 economic plant species to the world. In contrast the USA, which has the three times the landmass of India, has contributed only one important economic species (Sunflower) to agriculture, four others are of minor significance.

Conservation of biological resources is experted to make important contributions to social and economic development by bringing about greater agricultural productivity through control of pests and pathogens, by bringing about climatic and edaphic changes, by

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GEOENVIRONMENTAL DIVERSITY OF GUJARAT

Prof. S.S. Merh

The state of Gujarat comprising approximately 2,00,000 sq km. in area, provides an interesting terrain diversity, and is perhaps the only state within which the verious geoenviornmental perameters show a wide variety. Unlike most other areas of the country, Gujarat is marked by all the three major geoenvironments-marine, fluvial and eeolian Tha long coastline of Gujaret, the extensive elluviel plains of Mahi Narmade, the saline westeland of the Ranns of Kachchh, arid and semi arid areas of N. Gujarat and the rocky highlands of eastem and southern Gujarat, all heve their own terrain cheracteristics.

The two main controlling factors responsible for geoenvironmental diversity are 'geology' and 'climate'. The geological conditions ere governed by the rocks and their structural dispositions, while the climatic factors comprise rainfall, temperature and wind Geologically, the state of Gujarat provides a wide range of rock types of different ages ranging from the Aravalli Mountains as old as 2500 m y. old in the NE to the unconsolidated alluvial and beach material in its central and western parts only a few thousand years old.

Almost all important rocks occur within the state of Gujarat We not only have the metamorphic rocks like granite, quartzite, schist and marble but we also have sedimentary rock like sandstone, limestone and shale and extensive a alluvial and coastal sediments. Vast areas of Gujarat are occupied by the volcanic basalts. The climatic conditions also show a great variation from south to north and east to west, and all these factors are fully reflected in the surface and subsurface conditions.

On the basis of terrain attributes like geology, topography, drainage and surficial deposits, the state of Gujarat can be divided into eight following geomorphic divisions viz.

1. Northeastern crystalline hills.
2. Trappean highlands of South Gujarat.
3. Rocky tablelands of Kachchh Saurashtra
4. Arid and semi-arid plains of North Gujarat.
5. The Ranns of Kachchh.
6. Alluvial plains of Central Gujarat.
7. Uplands of South Gujarat and
8. Coastal areas

Northeastern crystalline hills comprise the northeastern fringe of Gujarat bordering the state of Rajasthan and Madhya Pradesh. The entire terrain is hilly interspersed with intervening low grounds that support a thin cover of local alluvium and residual soils. The topography is fairly rugged, the average altitude ranging between 150 to 300 m with some hills and ridges rising above 300 m even A few peaks around Ambaji are more than 1000 m high.

The rock formations belong to the Aravalli and Delhi Systems and consist of quartzite, schists and marbles intruded by granites of Erinpura age Climatically, the hilly areas could be considered semi-arid. Soil cover is by and large thin, a few metres deep, and is of residual type or alluvial, deposited locally by the rivers. Banaskantha soils are dominantly alluvial sandy while those of Sabarkantha and Panchmahals are rather mixed-residual sandy as well as medium black soil.

Within this hilly track the annual rainfall shows a significant variation, being about 60 cm. (very low) to about 80 cm. (low) from NW to SE. The reliability of rainfall varies from very low to low. The temperature variation ranges from 20°C to 40°C, though occasionally temperatures as high as 47° and as low as 4°C have been recorded. Monsoon winds blow from the SW while during other months (winter) they come from NE. Except a few bigger streams which are perennial and contain year-round water, most smaller ones are ephemeral. The groundwater supply is erratic characterised by unconfined and rather shallow aquifers The overall landscape is mixed, desolate as well as forested/cultivated. A variety of building-stones like marble, limestone, granite, are the chief mineral resources and are extensively quarried for various industrial purposes

The geoenvironmental problems of these areas mainly pertain to scarce irrigation facilities, non-availability of adequate groundwater, haphazard distribution and overall paucity of cultivable land. Quarrying, road construction, minor irrigation projects and afforestation are the main developmental activities directly related to the quality of geoenvironment.

Trappean highlands of south Gujarat made up of highly dissected lava flows of Cretaceous period characterised by plateaux, ridges and hills, rising several hundred metres above the MSL. Rainfall in south Gujarat tends to be Fairly high, of the order of 2000 mm. or even more. Temperatures range between 10°C and 40°C. Wind directions during monsoon are south westerly, though during other month, they could blow from the NW. Except for a few major rivers, most of the streams are ephemeral and tend to dry up during summer. Groundwater is erratic, and is confined to fracture zones in the basalt or occurs in the locally accumulated alluvial patches in the intermonatane valleys Wherever available, it occurs at shallow depths of a few metres only. Basalt forms an important mineral resource and is extensively exploited as building-stone and as road construction material

In such a terrain with heavy rainfall, attempts should be made to preserve all available surface water through small scale schemes of water storage.

Except for the coastline, practically the entire kachchha peninsula is rocky and hilly, though its topography is subdues and not very rugged. Its central portion is the highest averaging between 150 and 300 m. with occasional hills rising above upto 350 m even. A major portion of this geomorphic unit however shows altitude variation from sea-level to as much as 75 m. Geologically, Kachchha is very interesting and its rocks belong to Mesozoic sedimentaries of Jurassic and Cretaceous ages, and also those of Tertiary period. A considerable portion is also occupied by basalts of Deccan Trap and laterites derived from these volcanic rocks. The sedimentary rock types are sandstones, limestones, shales and marls and these are considerably folded and faulted. Soil cover is not thick, only a few metres deep, and the constituent soils are dominantly sandy loam, with a patch of black cotton soil in the central parts. Coastal areas have isolated patches of alluvial soils at a few places.

Climatically, the kachchha region can be considered as arid to semi arid with low and erratic rainfall. The rainfall varies around 300 mm. 50 to 100 mm. this or that way. Kachchha is frequently under the

spell of drought. Wind direction during monsoon is from southwest, though in winter season, northerly winds are quite strong and effective. During summer, the days are quite hot, the temperatures generally going above 35°C even beyond 40°, but the nights tend to be quite cool. Winter is equally severe, and the temperature could occasionally go down to almost freezing point.

There are very few perennial streams. All originate in the central highlands and flow in all directions, in most cases meeting the sea. In recent years, considerable efforts have been made to store monsoon waters by building checkdams on several rivers. The groundwater conditions are by and large, unfavourable. Coastal areas have predominantly saline water, while the sandstone terrain is suitable for open wells as well as low yield tube-wells with aquifers available between 150 and 300 m. depths. Some of the Tertiary rocks provide good sites for open wells.

Bauxite and lignite are two main mineral resource while locally, some rocks are used as building material. Economic development of Kachchha region is in offing and it is very essential that before exploiting its available resources and developing various areas, a careful scrutiny of the various terrain factors is made, for the purposes of a harmonious balance between the maximum that terrain can give and what we can take out of it.

The triangular landmass of Saurashtra forms a vast tableland gently sloping in all directions. It shows a gradual fall in altitude from a little above 150 m. in the central part. Occasional peaks and hills, even nearer to the coast, rise to spectacular heights, the Barda hill rising to 640 m., Osham to 640 m. and Girnar to about 1120 m. Geologically, almost the entire peninsula is made up of a Deccan basalts which are fringed by Tertiary and Quaternary rocks. Soil cover is thin and of the medium black type. Soils along the northern flanks are alluvial sandy loam, while along the SW and E. near the coastline, soils are saline. The Girnar hills and its environs support a rich fertile forest soil. The average annual rainfall tends to be around 400 mm. in the NW to almost 700 mm. in the SE. The area around Girnar receives a higher rainfall averaging 800 mm. or more. Temperature variations are as usual between 20° to 40°C, occasionally going up during summer days. Wind directions during monsoon are southwesterly, while in winter the winds blow either from NW or N. Except for a few major rivers, most get dry during summer. Almost all ephemeral streams have been harnessed by constructing check dams for the purposes of

storing monsoon waters. The Saurashtra region is marked by acute groundwater problems. While tha availability of groundwater is erratic in the trappean areas, the coastal plains have furnished reasonably good quality of unconfined fresh water. Unfortunately over exploitation of this sweet water supply has caused serious threat of ingress of saline water in coastal areas.

Major mineral resources ara laterites, limestones and basalt. The main problems facing Saurashtra is that of adequate water supply for irrigation, industry and domestic needs. Considerable attention is therefore being paid towards harnessing all available groundwater and surface water in Saurashtra. Coastal areas are getting more attention *because there the available sweet-water supply is threatened by* increased salinity.

Falling within the districts of Mehsana and Banaskantha, tha arid and semi-arid plains of North Gujarat comprise a rather unique terrain. Predominantly, the landscape is marked by a rather featureless ground with sporadic rocky occurrences of granitas, tha averaga ground level ranging between 25 and 75 m. Geologically, tha deposits rapresent Pleistocene alluvium and Recent aeolian sands.

Though at most places these unconsolidated deposits are sevaral hundreds of metres deep, the surface cover mostly consists of coarsa sandy soils derived from granitic and other metamorphic rocks. Falling within a zona of a very low rainfall reliability, the total annual rainfall averages between 400 to 600 mm. The temperatura variations ara quite high, and during summers, day temperature could occasionally go as high as 50°C and drop down even below 0°C. Southwesterly monsoonal winds are least effective in the part, whereas northerly winds bring considerable blown sands from the north, thus adding to the barren-ness of the terrain. There are few perennial rivers, surface irrigation facilities too are poor and groundwater availability is equally difficult. Most of the wells are deep, the water occurs under artisan conditions at depths of mora than 150 m. Considerable developmental activities have been taking place *in this region* and *irrigational facilities* through surface storage as well as tube-wells hava been provided It is rather unfortunate that uncontrolled exploitation of groundwater has caused much damaga to the aquifers. This part of Gujarat, forming the international boundary, needs special attention, especially from the view-point of economic development and rapid communication

The Great and the Little Ranns of Kachchha, are geoenvironmentally unique in the world These comprise vast saline wastelands

featureless and gradientless, hardly rising 4 to 6 m above the sea-level. Annually inundated by tidal waters and rain water during monsoons, these desolate areas have given rise to an expansive salt encrusted terrain where nothing grows, and the soils and the groundwater are highly saline. The average annual rainfall is very low being of the order of a maximum of 300 mm. Strong SW monsoonal winds push tidal waters of the Arabian Sea almost 200 Km. inland. Northerly winds quite often push the stagnating tidal waters southward, thus causing considerable damage to the grasslands to Banni which fringe the Great Rann to the south. The groundwater is shallow and saline, and sweet water availability is restricted to monsoon months only.

The Great Rann forms a very sensitive international border and we cannot afford to neglect this region. Special efforts have to be made in developing it. But care has to be taken in construction of roads and ambankments in the Rann which could caused imbalances in the naturel geoenvironment and thereby augment to the problems of waterlogging and salinity ingress along the Rann fringes.

It is therefore most essential that the Ranns are extensively investigated before taking up further development activities, and ambankment construction.

The vast alluvial plains of Central Gujarat which form the most prosperous region of the state, comprise a thick pile of fluviel sediments brought by the rivers of Sabarmati, Mahi, Dhadhar and Narmada. Restricted to an altitude range of 25 to 75 m these plains slope very gradually seaward and are cut by the incised meandering river courses of Mahi, Dhadhar, and Narmada and their tributaries. Geologically, the plains consists of sands and silts of Pleistocene and Holocene periods are represent ancient flood plain deposits. Mostly the soils are of sandy loam type, though occasional patches, especially southward, are of medium black type. Rainfall tends to show an increase, fluctuating between 700 mm. in the north to as much as 1000 mm. in the south. Heavy downpours are not uncommon. Temperature variations are moderate, ranging between 20°C and 40°C, only occasionally during summer, it may go to 42° or 43°. Exceptionally colds days could be 10°C or so. Wind directions are as usual southwesterly during monsoon and northeasterly during rest of the year.

Across these plains flow the major rivers of Gujarat, which enter the state from the east and carry huge quantity of water and detritus all

the year round. These rivers get flooded during periods of heavy monsoon.

The groundwater conditions are also quite favourable. Unconfined water is available in dug wells at shallow depths in most areas, and deep bores upto 150 m. depth have yielded abundant sweet water. In fact, many areas in Kheda district are threatened with the hazard of waterlogging caused by the combination of factors of decrease in utilisation of groundwater and increased surface irrigation.

These alluvial plains have received maximum attention in terms of harnessing and exploitation of the river water and other developmental activities. A variety of environmental problems are faced by these plains and it is most essential that serious thought is given to a proper plan of geoenvironmental management of these plains for future development.

Broadly falling within the limits marked by Narmada and Tapi rivers, these uplands of South Gujarat show a marked topographic difference from the alluvial plains. The terrain to the east of the coastal alluvial plains tends to be rocky and rising upto 150 m, the alluvial cover progressively thinning out. The alluvium is a depositional product of Narmada, Kim and Tapi rivers. The soils are of deep black type whereas the soil cover eastward is mostly of residual type deriving its material from the Tertiary rocks and basalts. Geologically, from west to east, this portion contains alluvium, Tertiary rocks and basalts. There is no significant variation in temperature pattern, but rainfall tends to show some increase, ranging from 1000 mm. to 1400 mm, pointing to a gradual increase southward. Monsoon winds are southwesterly. There are numerous perennial streams, but they are mostly sluggish and meander through the uplands and coastal plains. The only major river is Tapi, which carries a lot of water and tends to get flooded during monsoon.

The alluvial portions are suitable for shallow dug wells as well as for low yield tube-wells; the rocky areas have undependable groundwater resource. Local accumulation of alluvium provides groundwater that could be tapped through dug wells. This geomorphic unit has not been adequately investigated and almost all aspects of its terrain attributes need a critical appraisal.

Gujarat is characterised by about 1600 km long 16 km wide coastline which shows considerable diversity along its length. The different segments of the coastline are controlled by diverse factors

geology, climate and onshore and offshore coastal processes. The geological diversity is reflected in the coastal rocks over which are shoreline sands and silts are deposited. In kutch and Saurashtra, the coastal areas dominantly comprise Tertiary rocks, while in the Mainland, they are quaternary alluvium of Deccan basalts. Geomorphically too, the coastline shows much variation. The kutch coast is smooth gently sloping, while that of Saurashtra is rocky, made up of cliffs of milliolites. The mainland Gujarat coast is divisible into three types, to the north of Narmada, it is alluvial cliffy, while to the south upto Tapi or little beyond, it has a gently sloping alluvial ground Further south right upto the limit of the state and beyond, the coast is low but rocky marked by basaltic intertidal platform. South of Narmada river, sandy beaches become gradually prominent.

Tha offshore environmental conditions along the long coastline vary from one part to the othar. Restricted marine environments prevail in the Gulfs of Kachchha and Khembhat open sea high energy condition control west and south coast of Saureshtra.

Tides ara modarately high in the Gulf of Kechchha whila the Gulf of khambhat is characterised by very high tides. The Saurashtre coast does not receive much sediments through rivers, whereas the Gujarat coastel waters are very muddy on account of high detritus load of the inflowing rivers. A major portion of the Mainland Gujaret coest comes under the influence of tha Gulf of khambhat and thus absence of wave action, high tides and to-and-fro longshore drift of sediments hàva generated very peculiar coastline environmental conditions.

The geoenvironmental problems of coastline are many. Developmental activities have to take info account of problems of water supply, silting, coastal erosion, pollution of coastal waters etc. As the different parts of the long Gujarat coastline are controlled by quite diverse factors of geology, climate and coastal processes, no one single strategy for the entire stretch will be effective. Various coastal segments have to be investigated in detail and their problems have to be identified. The Gujarat coastline is not only important for industry and navigation, but it has great importance from the point of view of country's defence.

In this article and endeavour has been made to present a bird-eye-view of the terrain diversity of Gujarat, enumerating the various controlling factors. Two facts stand out, firstly, the region of characterised by a wide variety of terrain types, the different parts of the state revealing an interesting combination of geology and

environmental process, and secondly the factors of climate, onshore subaerial and offshore coastal processes within themselves, show well-marked variations from one part of the state to other. Obviously, the two sets of diversities, geological and environmental, have resulted into a fantastic variety of terrain types. Gujarat, in that sense is unique and so different from other parts of the country.

A proper evaluation of the various geoenvironmental parameters is most vital from the point of view of a successful management of terrain development activity. Our past experience has shown that various developmental projects, be they dams, canals, tubewells, roads, harbours or mining and oil exploitation activities, all these if not properly planned, cause immense and sometimes irreparable damage to the quality of life, thereby defeating the very purpose for which the developmental activities ara taken up

What is now urgently needed is a concerted and Integrated effort by geoscientists to thoroughly investigata all the geomorphic characteristics environmental factors and work out a developmental strategy for Gujarat so that maximum benefit is derived out of its terrain with minimum creation of geoenvironmental imbalances.

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DEVELOPMENTAL STRATEGY THROUGH ECOLOGY

Madan Mohan

Ecology studies relationship between organism and its environment. In other words, ecology is the scientific study of the relationship of a plent or animal to its natural environment[1]. This includes orgenism's responses to its physical surroundings as well as its interactions with other organisms. Empirically, the term 'ecology' was coined by Ernst Haeckel[2] in 1869. He defined ecology as the total relations of the animals to both its organic and its inorganic environment. Since then, many authors have defined ecology in various ways. They all are unanimous in the opinion that ecology deals with the interactions between organism or organisms and its environment. It would be worth pointing out thet the early euthors emphasized on the structure of the relationships whereas the later authors showed greater concern for the functioning of these relationships. In the middle of this century, it was realised that both the structure and the functioning of the relationships are important in the understanding of ecology.

The first comprehensive definition of ecology was given by Eugene Odum[3] in 1962. He defines ecology as 'the study of structure and function of ecosystem'. Ecosystem is the fundamental unit of study in ecology. The term was coined by A.G. Transley[4] in 1939 to express the sum total of organisms and their physical habitat. A more generalized definition of ecology was given by Margalef[5] in 1968. He defines ecology as "the study of systems at a level in which individual or whole organism may be considered elements of interaction, either among themselves, or with a loosely organised environmental matrix". He adds further that system at this level is named ecosystem and ecology, of course, is the study of ecosystem

PROCESS OF DEVELOPMENT

The term 'development', considered as a process, is expressed into many ways. Sometimes, it is used for a 'change' only; but sometimes, it is used to mean 'gain' or profit. One helpful understanding of the term is that development implies change in favour of general human improvement. There are two kinds of change which are usually inter-linked such as expansion in consumption and enhancement of welfare. Development is, thus, both a material and an organisational matter[6]. The development process is operationalized by the integration of the three elementary forces i.e. the Nature Technology and Institution. The Noosphere- the sphere of man-nature interaction-may be viewed as a triangle of these forces. Nature provides the bases, lays down the limit of freedom and indicates the direction along which optimum appropriation through social labour is possible in the long run. Technology aids natural processes, bonds them to human purposes, modifies them and thus extends the range of freedom. Institution is either favourable to or restrictive of man-nature interaction through technology. Thus, the development process evolves itself through integrating the human and the non-human components into a system of interdependence. The eco-crisis of the contemporary times is a consequence not of e. technological advancement but of an institutional frame, which is no longer capable of coping with it. However, the crisis solution is not a stoppage of technological advancement but a new modified adjustable system which can regulate man's relation with nature as well as man's relation with man

The all-round rapid development and the influence of man upon the environment as well as the effects of those alterations upon human health and welfare became a focus of analysis and evaluation of the present-day concern. Hence, the debatable issue that arises is such as ecology-technology, man-environment relationship and population-environment-development syndrome Simultaneously, the concept of development and undergone significant change. Development is concerned primarily with the well-being of the people. Development encompasses institutional changes including the distribution of national income, development benefits, knowledge and perhaps power. Basic needs strategy seeks to generate additional income and employment and provide services to the poorest segment of the population The distribution models of development seek to achieve economic growth with social justice, devolution of authority and democratization of social systems.

In the development process the 'modern' technology has failed to take care of 'the inner limits' of the human society and at the same time, has violated 'the outer limits' of the spaceship earth. It has disturbed the ecological equilibrium, jeopardised the ecosystem stability and improvised the environment with regard to both physic-biotic and socio-cultural aspects. These developments have led to the integration of an ecological dimension to the development process. Moreover, it is amply clear that the development and environment influence each other mutually and dynamically. However, the concept of 'sustainable development' based on an integrated view of environmental policies and development strategies, intends to maximise the economic benefits from a given ecological milieu and minimise the risks and hazards to the environment

ENVIRONMENTAL AWARENESS IN THE WORLD

To comprehend the man-environment interrelationship through sevaral variants of possibilism end determinism, the technologicel inganuity of men was appreciated. Dunng the late 1960's, the economic optimism end technological determinism was being implicitly rejected. Therefore, the emphasis during this period was on 'an elternative concept of space in subordinate, that is, whera space is not separated from en understood independent of the object under study. Alongside, positivism's myth of the possibility and desirability of 'value free' science put an effective stop to normative research.

During the late 1970's many kinds of obstacles had ansen in the development process; such as the rising cost of energy resources, especially petroleum, environmental disruption and resource depletion. These were caused by the so called 'modern' technology. Alongwith this increasing socio-spatial disparities at various levels, rapid population growth and massive rural-urban transfer and deteriorating quality of life, necessitated a change in the development paradigm. Therefore, the main ingredients of development strategy in the light of which main highlights are such as the satisfaction of basic human needs, alleviation of absolute poverty, growth with socio-spatial equity, development with environment improvement, mass participation, self-reliance and appropriate technology alongwith income and employment generation. Moreover it seems necessary to evolve a comprehensive environmental evaluation system through which the increasing pollution, resource depletion and environmental deterioration problem would be under control. The elements of economic

feasibility, social responsibility and ecological accountability are the main ingredients of the system.

There has been growing awareness throughout the 1980's that development objectives like maximising economic growth, ensunng a fair distribution of available wealth and development benefits and minimising the negative effects of human actions and the environment are interlinked. Equity and growth as well as environmental conservation and development must be viewed as simultaneous and not as sequential process. Maintaining the quality of environment and improving the quality of life are interconnected. Our common future (1987), the third milestone laid main emphasis on the ecodevelopment direction as well.

ECOLOGY AND DEVELOPMENT SYNDROME

Ecodevelopment means to Imply desirable, soft change for a human social group. The change is not only to consider better but in broad, social and ecological equilibrium[7]. The term 'Ecodevelopment' was used by Maurice Strong in the Stockholm (Sweden) in June 1972. Ecodevelompent was a word coined to descnba a process of ecologically sound development, of positive management for human benefit. Thus, ecodevelopment indicates a 'best fit' to optimise the balance between population numbers, locally available resources end culturally desired life styles[8].

Ecodevelopment implies a particular technical style. The development of techniques will play a very important part in ecodevelopment strategies. It is obvious that the coexistence can ba achieved between various objectives, economic, social and ecological. Since technological change appear to be the principle multi-dimensional variable in the development process, but it would be wrong to correlate ecodevelopment merely to a technological style. It calls for certain social organization producers and new education system. The institutional framework for development cannot be defined in the abstract without regard to the specific features of each case. The three basic principles of it however are stated eloquently. Firstly, ecodevelopment calls for the establishment of a horizontal authority that is capable of looking beyond the interest of particular sector, is concerned with all the facts development and is able constantly to control the complementarily the different activities undertaken. Secondly, such an authority be efficient without the participation of the population concerned in the realization of ecodevelopment strategies. This participation is essential for the development and harmonization of

actual needs for the identification of the productive potential of the ecosystem and for the organization of the collective effort to develop it. Thirdly, it is essential to ensure that the results of ecodevelopment are not negated by any plundering of the populations concerned, by intermediaries acting as contacts between the local communities and the national market. Environment and development are not separate challenges They are inexorably linked Development cannot subsist upon a deteriorating environmental resource base The environment cannot be treated separately by fragmented institutions. They are linked in a complex system of cause and effect. Thus, economics and ecology must be completely integrated in decision making and law making processes, not only just to protect the environment but also to protect and promote development Economics is not just about production of wealth and Ecology is not just about the protection of natura. But they are both equally relevant for improving tha lot of human kind. Indeed, environment and economic problems are linked to many social and political factors For example, the rapid population growth that has so profound an impact on the environment and on development in many regions is partly the result of such factors as the status of women in society and other cultural values Also, environmental stress and uneven development can increase social tensions.The distribution of power and influence within society lies at the heart of most environment and development challenges. Region or national boundaries have become so porous that their traditional distinctions hava totally lost significance. Ecosystems do not respect national boundaries. Water pollution moves through shared rivers, lakes and seas The atmosphere carries air pollution over considerable distances

CONCLUSION

Thus, the environment, the energy and economy alongwith technology and space determine the process and nature of development. These elements have interlinkages both direct and indirect. These components and the interlinkages together provide a viable alternative to the traditional growth-oriented models of development. It illustrates the development of an appropriate technology and promotion of a rational use of environmental resources So, the long cherished objectives of sustainable development are achieved. It provides a new dimension to the environment development syndrome. In due respect, it keeps the human welfare in the centre and the technology and economy providing the base to the entire system.

Experience shows that development which takes place at the cost of environment can only be a short-term development. In the long term, it can be anti-development and it can go on only at the cost of enormous human sufferings, increased poverty and oppression Therefore, a balanced and sustainable development requires an understanding of environmental processes. In this regard management of land and water resources must be considered. It is not an easy task unless determined effort is made. Consequently, components like sustentation of environment, transformation of technology, lesser consumption of conventional energy, maximization of employment opportunities, naturalization of deprivation trops and strengthening of the trickle down process are not only interrelated but rather mutually reinforcing in the process of development.

The symbiotic relationship between man and environment is found to vary over space. Wherever this relationship exists that is called "ecological balance" and whenever such environmental factors cannot support human needs and aspirations because of exterior deterioration and over-exploitation of such environment it is called "ecological imbalance". The balancing factors in environment and human relationship are multi-dimensional and complex in nature. The Ecology and Development syndrome described above in the foregoing manner points out clearly to erroneous strategies- Firstly, the strategy of "development" at all cost, leading to eco-destruction and, Secondly, the strategy of rejecting development in the name of ecology. In the light of discussion presented above the conceptual frame that the ecology development contradiction is a false contradiction. The laws of nature not only impose constraints on but also point to the direction of optimal development This dual relationship between the ecological correlates and development process is fully recognized. However, the main concern with ecology within the framework of an ecosystem approach is directed towards optimizing (and not maximising) development. Let us save ecology from development no doubt but at the same time, let us save development from ecology as well. Moreover, ecology is not opposed to development but it pleads that any development plan be examined for its environmental impact before implementation. The ecology also pleads for preservation of unique ecosystem for the future generations because man can never reproduce such ecosystem.

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ENVIRONMENTAL MONITORING, DEVELOPMENTAL STYLES AND RESEARCH STRATEGY IN INDIAN DESERT REGION

R. B. SINGH

INTRODUCTION

About 36 per cent of the land surface and half of the countries of the world face problems of desertification. The major deserts exist in tropical parts over western margins of continents. Nevertheless other lands are also affected by desertification through their extreme temperature, low rainfall and aridity. These areas contribute towards low productivity and ecological degradation. The desert regions which represent the complex and interrelated ecosystem of our planet are rapidly changing. The human and livestock population are increasing at a rapid rate. They are susceptible to accelerated hazards and desertification. There is widespread poverty among inhabitants. Thus, the proper resource management and socio-economic development of the people deserves immediate action. Recognising the interplay of ecological and developmental factors, there is an urgent need to generate and strengthen knowledge about the ecology and sustainable development of the arid land ecosystem on the one hand and promoting integrated development and alternative livelihood opportunities.

Ecological degradation is the major critical issue in any desert land because it causes human disaster. Desertification is considered as a human problem (Eckholm and Brown, 1977). Man is both the main cause and the victim of such ecological degradation. Despite frequent droughts and impossible living conditions, the human and livestock population in the Indian desert area is increasing at an alarming rate. This has considerably increased the biotic interference in the natural environment resulting expansion of the desert. There is urgent need to

streamline and human activities in the region, strictly in consonance with its ecosystems. In this context, consistent and accurate environmental data are prerequisite to protect natural resources and environmental quality. Ecological studies have always been a major concern among geographers since long. Therefore, geographical monitoring should be considered as an integral part of such studies. This approach is conceived by geographers as geosystem monitoring, describing natural-economic monitoring The concept of ecological monitoring (i.e. a system of observation of anthropogenic changes in the environment) is now very popular (Gerasimov, 1983) An effective monitoring system of natural and man-made changes should enable to observe complex process of desertification at an early stage. This will further help to forecast such changes and will also provide sound base for resources management strategy.

The present paper attempts to assess landscape degradation for future potential risk of such degradation in desert region Priority has been given to monitoring renewable resources. It is anticipeted that such assessment will form the base against which future changes can be measured. It shows that there are two groups of indicators to be monitored. the physical set of indicators and the socio-economic (human) ones.

INDIAN SEMI-ARID AREAS AND THE STUDY REGION

Broadly Indian semi-arid land lies in the states of Rajasthan, Gujarat and Haryana besides small areas in Andhra Pradesh and Karnataka.

The Indian desert region extends approximately 21° and 31° north latitudes and between 69° and 76° east longitudes. It comprises about 295,000 km^2 area of western Rajasthan incorporating 11 arid districts and 60 sub-units (Tehsil) west of Aravalli. The region with population of 10.9 mill (1981) is one of the highest densely populated arid regions of the world. It supports large human population (64 persons per km^2 in comparison to 3 in other arid regions). It shares 61 per cent area and 39 per cent population of Rajasthan state.

The Thar desert is a large desolate sandy tract, devoid of surface water, receiving capricious rain-fall. A lower rainfall bring periodic drought and famine conditions causing large scale migration of people, with their herds of cattle to neighbouring lands causing great hardships

It was early realised that irrigation water is the principal means in this region which could change the scenario of scarcity to prosperous agriculture.

The empirical study also covers three tehsils of Ganganagar district which have come in the command area of the Indira Canal, namely Hanumangarh, Suratgarh and Anupgarh. This district has a unique situation of receiving canal irrigation through several irrigation networks in the last four decades. It, thus, provides a rare combination for eco-geographical studies due to existence of original desert ecology, having rainfed agriculture besides the changed landmass which has come under assured irrigation supply, in varying stages of environmental transformation through successive laying out of irrigation networks. If water for irrigation could be provided, it would change the scenario of scarcity to prosperous agriculture.

GEOGRAPHIC DIMENSIONS OF NATURAL AND HUMAN RESOURCES

Almost all physical and economic resource charecteristics of the region depend upon the prevailing climetic conditions. The annual reinfell is below 10 cm in western most Jaisalmer. It varies 10 cm in western part to 40 cm eastern sides. It is charactrised by extremely high range of temperature and aridity. The sand dunes are found in most part of the area. Sri Ganganagar has plain area formed by older alluvium. There mainly two types of soil exist : i) Yellow brown (desert) soil found in western and northern part of the region, and contains about 90-95 per cent sand and about 5.7 per cent clay, high pH value, much soluble salt and some amount of calcium carbonate with poor organic matter, and ii) Grey brown (desert) soil found in the eastern part of the study area, containing rich organic matter and nitrogenous element. Ground water table is very deep (91-120 metres). The region has limited mineral resources, i.e. copper (Jhunjhunu district), marble (Nagaur), gypsum (Bikaner, Jodhpur, Nagaur, and Jalor), sandstone (Nagaur, Barmer and Churu) and limestone (Sikar, Jhunjhunu and Jodhpur districts).

Eastern part is densely populated than the western part of arid region; the average density of population is very low (64 persons per km^2 in 1981) as compared to national average (216 persons). Western districts like Jaisalmer (6) and Bikaner (31) are the areas of low density. The north-eastern areas, i e. Jhunjhunu (204) and Sikar (178) are the areas of high density. Of the total population 21.31 per cent is

characterised as urban which is higher than that of the state, varying from 8.06 per cent in Jalor to 39 01 per cent in Bikaner district (Table 1). Rapid urban growth has been observed in Sri Gangnagar district due to agro-industrial development. About 22.25 per cent population is literate which is lower than that of India (36 12) Literacy rate of males is 33 60 per cent as against 10.80 per cent of females in 1981. Poverty, lack of educational institutions, poor transport connections to the growing population have caused low literacy in the region.

It is less fertile and suffers from lack of moisture and poor irrigation. Therefore, only slight increase in net sown area is recorded but overall agricultural output has not been much affected. Agricultural efficiency Indices have positiva relationship with the rainfall and percental arid area. The indices vary from 54 5 in Jaisalmer to 139.5 in Sri Ganganagar. The working force consists of 29 44 per cent which is below the national average (33 4 per cent). In the western Rajasthan, 71.81 per cent of workers are engaged in agricultural activities and rest in non-agricultural activities (28 19 per cent) with maximum (42.81 per cent) and minimum (17.22 per cent) in Bikaner and Barmer, respectively. Only 3 99 per cent of workers are recorded in household industry. Sri Ganganagar records the highest proportion of immigretion due to the new agricultural economy based on irrigation facilities. Here ebout half of the population that lives at present, belongs to outside the place of birth category. The rural-urban migretion vanes from 2.8 per cent in Jalor to 9.2 per cent in Bikaner district (Singh, 1984).

DESERT ENCROACHMENT

Desert encroachment is a serious problem in Indian arid zone. There have been fears expressing that Thar is spreading across parts of Rajasthan, Gujarat, Punjab and Haryana,. According to studies conducted by CAZRI in Jodhpur, 9290 km^2 (i.e., 4.36 per cent area) of western Rajasthan is already became desert in the last decades and additionally 162,900 km^2 of area is vulnerable to desertification. Recent topographical surveys show the spreading of desert towards Ferozepur, Patiala, Delhi and Agra at the rate of about half a km per year for the last few decades, moreover, it is encroaching fast upon the fertile land. But the meteorological record over previous 70 years showed no significant change in rainfall, temperature and humidity over the desert areas. So the cause of desertification is attributed to the human actions. Increase in population and lack of alternative

employment opportunities have left the people living in the arid region with no choice but to continue grazing of cattle.

EXPANDING OVERGRAZING

The desert has faced an unprecedental growth in its population in the last 30 years, i.e. from 5 33 million in 1951 to 10.9 million in 1981. The increase of cattle population (51 per km^2 in 1983) has resulted to unbearable pressure on the restricted grazing area that exists in the desert. During 20 years between 1951 and 1971 the cattle population increased from 10 27 million, to 16 44 million.

Livestock is an important asset of Rajasthan arid zone, next only to agriculture and in certain pockets of western Rajasthan where drought is a regular phenmenon. With more than 40 million heads of livestock, Rajasthan ranks third on India's animal wealth. The state's sheep population is about 16 per cent of the country's total population The livestock population has steadily increased in the last three decades. The number of cattle, buffaloes and sheep increased by 25 par cant, 72 per cent and 100 per cent, respectively, while the number of goats increased by 338 per cent between 1951-83 (CSE, 1985). The rapid rise in goat population has alarmed many ecologists They are considerad more harmful for soil conservation becausa they consume all ground vegetation. In this way, increase in livastock pressura caused serious overgrazing

DECLINING GRAZING LANDS

In all the 11 districts of the arid zone, grazing areas have declined consistently since 1951-52 (Table 1). In 1983 grazing land has gone down to 7 6 mill. ha between 1961-71, while the area used for grazing animals increased by 63 2 per cent; this resulted to create imbalance between animal population and grazing lands. Local data from Luni block indicates that the grazing capacity of the land is approaching its limit and that the sand cover expanded from 25 to 33 per cent within the last 20 years (USAID). Land reforms also affected such common lands due to large scale conversion of public land to private use The slow destruction of regions's grazing lands has created serious problems for the management of vast animal population, and particularly the affected mass is the nomadic population. Stall feeding has been repeatedly recommended by experts to stop ecological destruction but this is obviously impossible unless there is a massive fodder production programme (CSE, 1985)

Table 1 : Changing Common Grazing Lands In Indian Arid Region

Aspects	Years		
	1951-52	1971-72	1977-78,
Area of grazing lands (Mha)	11 3	9 2	8 7,
Area of grazing lands share in total geographical area(%)	60 5	47 9	45.1
Animals per 100 ha of grazing lands.	39 0	94 0	105 0,

Source Statistical Abstract of Rajasthan for different years as quoted by N S.Jodha

In this way, land available for grazing is reduced, and the numbar of grazing animals increased which make it a critical case for overgrazing, soil erosion and desertification.

IMPACT OF DROUGHTS ON PROCESS OF DESERTIFICATION

Over 70 million people and 18 million ha of cropped area spread over seven states, I e. Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Rajasthan and West Bengal are gripped by drought In 1992. The estimated loss in the Kharif foodgrains is reached to Rs. 300 billion and for cash crop like cotton and oilseeds the estimates reaches to about Rs. 500 billion (Table 2).

Table 2 : Drought Affected Villages (1992)

States	Villages affected	Cropped area Affected (mill ha)	Population Affected (in mill),
Gujarat	11,000	-	20
Maharashtra	28,000	59	30,
Rajasthan	40,000	78	30
Kerala	all villages	-	-

According to an estimate, western Rajasthan is expected to face drought at the interval of every 2.5 years Such frequent occurrence of droughts creates - the environment of desertification During 1971-72,

there was an increasing trends of dust storms. Whenever rainfall falls steeply, there is a sharp rise in the occurrence of dust storms It has a considerable significance in the soil erosion and desertification process. It also speeds up the process of their formation The process of desertification is further accelerated by overgrazing on the pasture lands due to lack of fodder during droughts An erratic climate and frequent failure of crops make the farmers all the way more dependent on the livestock. For this purpose, a knowledge of the drought climatology of the region, i e the frequency of occurrence of droughts its duration and also the intensity would be of immense help (Singh 1990).

RECENT DUNES FORMATION

Recent dune formation provides a sure evidence of desertification But it is not easy to convince that this phenomenon is simply a naturally controlled one, moreover it is also a consequence of human impact which is enhanced by land misuse of catchment areas of these sands. Information collected from the old and new topographical sheets reveal that most of the stabilized dunes in eastern part of Jodhpur, south-eastern part of Bikaner, Nagaur and Jalor have been reduced in height by atleast 3 to 5 metres which show the variation of sands within the desert in the recent years.

IMPACT OF MINING

In Indian arid region, mining adds significantly to other desertification process. The region accounts for most production of lead, zinc, tungsten, phospherite, gypsum and steatite. Other major minerals are copper ore and lime-stone. Between 1970 and 1976, there was 86 per cent increase in area under mining for almost 50 different minerals According to Mann and Chatterji, the existing mining regulations have taken into account only the systematic and complete exploration of mineral deposit without any consideration of the after effects of the mining operations on land productivity. Removal of vegetation and waste disposal of mining in arid areas increases erosion process (CSE, 1985). Desertification processes originates from such area. Development of soil salinity due to mining has degraded land around quarries in Jodhpur and near the gypsum quarries in Barmer district. The hydrology has also been disturbed affecting existing potential area for water harvesting through traditional methods like nadis and Khadins (Venkateswarlu, 1991).

IMPACT OF INDIRA GANDHI CANAL PROJECT

Ganganagar district is benefitted by major irrigation network called Indira Gandhi canal Pariyojana which bring surplus water of the Ravi and Beas rivers to the thirsty lands of Ganganagar, Bikaner and Jaisalmer districts of western Rajasthan. The canal water reached Ganganagar through Nasitawali feeder in the year 1970. The Ganganagar district is the first beneficiary and its three tehsils have come under the command area of this canal system. The canal draws 7.59 MAF water in 204 km long feeder, 445 km long main canal and 16 branch canals, altogether which makes up a total length of 6500 km and irrigates 0.54 mill ha land, it takes 60 days for the water to flow from harike barrage to the end of the main canal. It is thus one of the largest canal system of the world, which has transformed the rainfed subsistence agriculture into commercial and highly profitable farming system in India The canal has made Ganganagar district a cultivator's paradise

Changing Land Use Pattern

Tha canal has increased total irrigation area from 353,993 ha (1961) to 902,849 ha in 1981, and also the cropping intensity reaching to 110 per cent in Ganganagar district. This has introduced new commercial crops lika cotton and groundnut in Kharif and sugar beet and Berseem in Rabi season This has transformed tha agriculture scenario into a dynamic and prosperous farming system. There is a small increase in the land under forest, i e., 2988 ha in 1971 to 28,832 ha in 1981, but emphasis is increasing rapidly on afforestation work in the district as it is considered as key to improving ecological balance. In agriculture sector, therefore, there is no more land available for addition; the increase in production is possible due to better utilization of land resources and inputs like irrigation, fertilizer, mechanisation in operation, adoption of new crop sequences and selection of new high yielding varieties. The change in cropping pattern is perceptible in the district. We note that area under cereal and pulse crops has gone down from 1976 to 1981, whereas under oil seed, cotton and other cash crops it has increased illustrating the trend towards better utilization of land for more profitable agriculture. Even amongst the cereals and coarse grain, there is more land under high yielding varieties (HYV). For example HYU wheat has risen from 80,100 ha in 1971 to 1,55,000 ha in 1977-88. Consumption of inorganic fertilizers have gone up from 1,3093 tonnes (1970-71) to 3 8097 tonnes (1981). The farmers, during field survey were found as better adapters of new

and specific package of cultivation practices recommended by state agriculture department. The yield of cotton and groundnut in the Ganganagar district is found at par with maximum reported in the country. The attitudinal change of farming community for adoption of better technology promises for increasing crop yield along with improvement in ecological balance, thus finally challenging to all those forces which cause land degradation and environmental deterioration

ENVIRONMENTAL EFFECTS OF IRRIGATION

The increase in human activity in from of multifaceted develop ment in the arid tract, such as taking place in the district of Ganganagar has resulted in greater use of land and water, impending hydrological and environmental changes. The soil in the district has high sodium and calcium salts. It is found that the copious source of irrigation has supported movement of salt in upward direction due to impeded drainage and high rate of evaporation This salt accumulates at the soil surface, making the land unsuitable for cultivation except for a possibly few salt tolerant species During the survey of 'chalks' along the Mundawali Minor in Hanumangarh tehsil, the study recorded a large part of land which bears white irregular patches showing salt accumulation. The natives call such land as "Sem". The "Sem" is of recent occurrence, its pH value was 7.9, but EC was 15.0 mmhos/cc with high calcium carbonate content. The cause of salt deposition was found mainly due to faulty irrigation.

a) Soil Degradation

The ordinary people in the desert recognise soil degradation only when land productivity decreases. For monitoring purpose, it is essential to make assessment of indicators, i.e. lose of top-soil, salinity, alkalinisation, water-logging, decrease of soil moisture and water seepage, etc. Canal irrigation is necessary because raising the crops without irrigation is either not possible or uneconomical Moreover, the groundnut is saline in many areas and hence the potential for tube-well Irrigation is limited The introduction of Indira Canal Project has resulted in a significant increase in yield of various crops like cotton, sugarcane, etc But in all these areas water-logging and soil salinisation have emerged as serious problems. The problem of water-logging in the west of canal is more because there is no exit of excess water due to border. The canal irrigation also raised water table and as a result water-logging in certain low lying area has increased, resulting to salinity problem Soil survey revealed that 0.17

Million ha. mostly in Anupgarh branch have moderate to severe problems of salinity and alkalinity. Due to high temperature, there exists problem of high evaporation and high percolation. Salinity is also result of excessive evaporation About 76 per cent of the area shows high to medium vulnerability to land degradation process while the rest shows medium to light vulnerability The degraded land constitutes about 33 per cent of the area (Venkateswarlu, 1991).

b) Transportation of Soil to Water Reservoirs

Due to soil erosion the silting up to water reservoirs is enhanced. Canal system in desert area is in constant danger of being buried under shifting sand transport. This has become one of the most serious processes threatening the support of water in many areas of Indian desert region Desilting is relatively a difficult technical enterprise.

c) Loss of Water from Canals :

A study conducted by the central water and power commission in 1967 revealed that about 71 percent of water is lost in transit from the reservoir to the field as far as the unlined canals and distributors are concerned (Table 3)

Table 3 : Loss of Water from Unlined Canals due to Seepage

Sectors	%Age
Distributors	7
Canals	15
Water Courses	22
Field losses	27
Total loss	71

Source Interim Report, National Committee on the Use of Plastics in Agriculture, 1982

d) Increase in Water Table

There is gradual rise in water table all over the irrigated lands in Ganganagar district Water-logging is another menace introducing by canal network in the district This is due to a hard layer of gypsum present at a shallow depth in this tract. The canal authority has estimated that 8 per cent of the total 7,000 km^2 land in the command area of Indira Gandhi Nahar Pariyojana has possibility of gypsum

present in the substratum. It is estimated that out of this total area, about 500 km^2 area is already water-logged. The present rate in the rise of water table is by 60 cm a year. If the trend persists, expert believes that a quarter of the total command area will ultimately be affected by water-logged conditions

The seepage loss is another serious menace of the massive canal irrigation in the district. The Government has lined the main distributary but the minor along the chalks in the remote fields possesses seed for creating marshes along the water ways. It reflects a serious lacuna of planning the huge network whereas the canal is laid out to reclaim barren land, it has induced more serious condition of water-logged lands due to short sighted planning. The water-logging, by all account is a bigger menace to crop productivity, compared to paucity of irrigation in drier conditions. The arid condition allows growing of short duration rainfall crops where the water-logging will present

IMPACT OF CANAL IRRIGATION ON NATURAL VEGETATION

The complex ecology of this arid region has supported evolution of xerophytic plant life, which over years of evolution have adopted morphological, anatomical and chemical devices to draw its sustenance from scarce moisture of the substratum and use it sparingly and thus complete their life cycle in harmony with the surrounding environment. It is remarkable that the desert of western Rajasthan has a unique vegetation and floristic wealth; many species found here are endemic in nature

The desert vegetation in western Rajasthan is largely devoid of tree life both in diversity and number as compared to the other part of state located, south-east, as the soil gets dry due to high temperature and continuing heavy evapotranspiration (Gupta, 1989).

a) Need for Afforestation

The canal is very promising source of irrigation but it is in constant danger of being buried under shifting sand for which various protective steps are taken by the Government. The canal water provide a valuable source for afforestation in the desert tracts of Rajasthan to mitigate the harsh environment and also assist in reducing the cost of maintenance of canal and roads. The tree cover is expected to provide timber, fuel-wood and fodder to the men and his cattle wealth. It will reduce wind velocity, check occurrence of dust storms and drifting

sand Afforestation shall check the silting of canal from the ever shifting sand dunes Apart from improving the micro-climatic condition in the ecosystem, it will meet the demand of fire-wood, timber and fodder. a scheme of economic plantation was formulated by the Government Thus experimental afforestation in the study area was carried during the year 1962-66 to identify suitable species and workout methodology for their nurture under the local surroundings. Later in 1965, a regular afforestation programme was launched under the overall development of the Indira Gandhi Canal project area This programme later received financial support of the World Bank under "The world food programme" during 1971-75 years. This work set a trend in raising of new tree vegetation and its benefits were better realise amongst the people Gradualy, the afforestation became part of other plan programmes in this region such as Desert Development Programme and the Tree Plantation Programme

b) Shelter-belt Plantation

Tall trees of suitable species such as Dalbergia sissoo (Shisham), Accacia nilotica (Babool), Eucalyptus camaldulensis (Safeda) and Tamarix-articulata (Farash) are planted along the canal in rows. The rows are kept five metres apart and the distance between the trees in the row is kept at three metres. Thus, 660 plants are planted per hactare.

The Dalbergia sissoo and Accacia nilotica trees are expected to attain a height of about 20 mt and a diameter of 50 cm at the end of 10 years. The newly planted trees are provided irrigation facilities to help them through crucial period of establishment until they have developed their root system when these could rely upon moisture resource of the soil The internal rate of return on investment is expected to be 12 per cent. Tall trees of shisham, safeda, babool, etc. are also planted over the culturable wasteland along the roads. Sowing of castor seeds (Riccinus communis) and munja (Saccharum munja) tufts as done along water courses to accord protection to the tree species from occasional frost and also to act as a middle canopy in the shelter belt

Whenever the road passes through unstabilised sand dunes, planting is done only on the wind-ward side of the roads. These are planted with Tarmanx glauca and Accacia fortilis In such stretches the leeward side remains un-planted because of continous dumping of blowing sand. These tree-belts are irrigated either by direct flow from

the canal or by carrying water in rail tankers The internal rate of return on investment in this scheme is estimated around 9 per cent. It has been found that the trees have reduced flow of sand on the road, it has also reduced the loss due to wind erosion along the canal, and has provided shade for the population

c) Fuel-wood Plantation in Villages

In The canal command area the fuel need of people are met from the naturally growing Prospic cinerana (Khejri) trees and the Celligonum polygonides (phog) bushes With the advance of irrigation and colonisation of the area the population has increased rapidly As such this natural source of fuel-wood has got largely depleted, and in its absence the rural population bum cow-dung and agriculture wastes for meeting their domestic needs In order to replace cow-dung from use as a farm manure and to conserve natural vegetation cover, adequate supply of fuel-wood at reasonable prices has to be ensured As a result the Canal Command Authonty has reserved a piece of 12 5 ha of irrigated land in each village for raising the fuel-wood plantation for the benefit of local people

The fuel-wood plantation comprises of Dalbergia sissoo, Accacia Tortilis, A. Nilotica and various Eucalyptus species. These trees are spaced at the interval of 5 by 3 metres, providing 665 trees per hectare. The internal rate of return of this investment in the scheme is expected to be 11 per cent. This plantation will provide recreational facilities and will protect the land from wind erosion besides augmenting fodder supply in the region.

STABILISATION OF SAND DUNES

The western Rajasthan is estimated to possess 58.5 per cent land under sand dune infested area. The intensity of sand-dune affecting lands is placed in five categories Thus, out of this total, about 11.5 per cent land is very severely (80-100%), 4 8 per cent severely (60-80%), 14.7 per cent strongly (40-60%), 18 6 per cent moderately (20-40%) and 8 9 per cent slightly (10-20%) infested by sand dunes. The methodology for stabilisation of these shifting dunes consist of (a) protection of shifting dunes against all biotic interference, (b) laying of effective micro-wind breaks on the wind-ward side of dunes and (c) sowing of grass or transplanting of drought resistant trees on the lee-ward side.

The village survey data by NCAER indicates that out of the total surveyed villages, 81 per cent of them have reported decreasing trend in the occurrence of sand storms after 1970, the year of the commencement of canal irrigation. The empirical studies confirm this observation. While interviewing old and skilled farmers said that both the frequency as well as intensity of the sand storms have reduced in the last 18 years in Ganganagar. In particular, sand dune infested land was recorded to have covered by vegetation and it now showed reduced loss of soil by wind erosion. The plantation along metalled road also helped in showing dunes as there is less obstruction on roads which was stated to be more frequent in the past.

PROGRAMMES COMBATING DESERTIFICATION

The combating of desertification in western Rajasthan calls for several social aspects. These measures could be effective only when a combined effort of individuals, voluntary organisations, government departments and other allied agencies be made. The approach should be 'peoples" development through peoples' participation'. Recognizing the need for a sound management of the region, the state and union governments have added a new dimension to the spatial transformation of Indian desert. In this context various programmes operating at different level in the region of western Rajasthan for the economic and infrastructural development are outlined below :

1) The Drought Prone Area Programme (DPAP).

2) Desert Development Programme (DDP).

3) The Desert National Park (DNP).

4) Integrated Rural Development Programme (IRDP).

5) Indira Canal Project.

6) Colonizing Organisation

7) Central And Zone Research Institute (CAZRI).

These programmes acting at various level have adopted the following strategy on specific issues :

(i) Development and management of water resources.

(ii) Soil and water conservation measures

(iii) Afforestation with special emphasis on social and farm forestry.

(iv) Development of pasture and range lands

(v) Livestock development and dairy development.

(vi) Development of subsidiary occupation.

(vii) Development of infra-structure like drinking water, electrification and network of roads.

THE DESERT NATIONAL PARK (DNP) : CONSERVATION OF BIODIVERSITY

A national commission of agriculture was constituted by the government of India in early seventies to develop agriculture by the close of this century in India This commission has recommended for preservation of ecological balance in desert areas by providing establishment of a Desert National Park in this region. Apart from a purely tourist attraction, the desert national park will halp in the understanding end study of plant and animal life which has evolved in this critical ecosystem of Indian desert

Tha scheme consisted establishment of the park in three stages involving a total expenditure of ebout Rs. 35 million ovar a pariod of five years. Firstly, the area of the National Park has been classified es a core zone, free from Intervention of all human activities It is surrounded by a peripheral belt of controlled grazing and restricted farming Secondly, a research centre is being developed within the park to conduct special studies on tha desert flora and fauna which is endemic to this region And lastly, a network of tourist observation posts are established Thus, the entira project is aimed to preserve natural habitats as well as to protect the unique plant and animal life found there from human interference. It will allow the process of evolution taking place in the plant and animal life and forestal ecological imbalance due to interference in the name of development.

NEED FOR EFFECTIVE RESOURCE MANAGEMENT STRATEGY

As canal irrigation has opened new avenues for intensive agriculture, forestry and horticulture, it is impossible to check the progress of new settlements, colonization and industrialization. It is therefore, necessary to introduce advance technology in these fields to protect the habitat from ill-effects It may be seen that the benefits of the technology are not corned by a small class of neo-rich settlers in the district, which may cause intra-class disparities and rivalries. The government itself has brought out several new programmes to make judicious management, better soil and water conversation, develop

social and farm forestry, pasture and range lands and provide avenues for subsidiary occupation to release pressure on land. However, it will be better for the state to integrate the planning at district level and remove the multi-facet funding and sectoral operation of different schemes with overlapping mandate Emphasis be lend on introduction of drought prone varities of crops which can do away to some extent the demand for frequent irrigation New devices to optimum use of water like drip and sprinkler irrigation be supported Large scale development of forest plantation, shelter belts against erosion pasture development also be carried together with integrated area development planning which may include soil conservation, social forestry, and introduction of fodder crops in cultivation Seepage loss ba plugged on priority. Mora emphasis may be granted to silvi-pastoral colonisation in tha region with emphasis on sheep breeding The local skill be developed and utilized for tha entire plan development with peoples participation both in planning as well execution of Iha development programmes in the district. The extensive participation of local people is likely to imbibed a feeling of ownership of the resourcas to prevent mis-use and protect the ecological balance and combat furthar desertification and land degradation. The mobolization of the society in tha development planning of the region will strengthen local institution and build up better infrastructure facilities for all developmental works envisaged for improving agriculture, forestry, horticulture, animal husbandry and establishing new agro-industries and ancillaries without affecting tha land and its scarce physical resources in this fragile environment (Singh, 1990).

The following research strategies are tentatively suggested for sustainable development of the region:

1. Micro-level assessment of desertification problems at district or block level.
2. Establishing local priorities for actions against implementation of actions in accordance with national plans.
3. Preparation of land use plans based on land capability classifications and the dominant socio-economic conditions.
4. Effective use of the development of rain-fed/dry land farming techniques.
5. Improvement of range lands through regeneration of natural vegetation. The highly overgrazed culturable or unculturable land should be utilised for Agri-Silvi-Pastoral-System.

6. The integrated approach to management of forest lands, grazing lands and croplands.
7. Afforestation and development of pasture lands to create fodder and fuel bank in each village.
8. Sand-dune stabilization through plantation grasses, fodder trees and controlled pasture lands.
9. Selection of suitable species for plantation.
10. Improving livestock development programmes so that villagers are induced to keep fewer but productive cattle. Number of animals should confirm to the carrying capacity of the area.
11. Shelter belt plantations along canals and roads
12. Development of relevant indigenous technologies to improve and rehabilitate soils and vegetation through soil moisture conservation.
13 Effective integrated schemes for proper use, conservation and recycling of the rainfall, surface and ground water for drinking and Irrigation purposes
14 Development of such non-conventional energy sources such as solar energy, gobar gas and wind mills
15 Development of labour Intensive occupations with the purposa of absorbing labour surplus from agricultural areas.
16. Appropriate use of environmental technology in above fields. CAZRI has already developed lew such technologies.
17. Promoting research collaboration among national and international agencies l, ,. universities, research institutes, and governmental institutions.
18. Establishing research and training centres in the affected areas in order to investigate specific local problems and to train local people in their native environments.
19. Social measures to encourage people's participation in the anti-desertification programmes.

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14

ENVIRONMENTAL PLANNING PROBLEMS IN CALCUTTA : A DEVELOPMENT STRATEGY

Rathindranath Paul and C.R. Pathak

INTRODUCTION

As the rate of urbanisation is increasing at a very fast rete, preservation of city environment hes become a very importent matter of concern no-a-days. In the third world countries the rate of urbanisation is higher than that of developed countries Beceuse of leck of consciousness of the people and callous attitude of the planners and decision makers regarding environmental preservetion overell situetion of the city environment in these countries has become highly deplorable Indie's urban population has increased in 30 yeers from 79 millions in 1961 to 217 millions in 1991. Another important thing is that in India all the 23 million cities have grown in population very fast. Their percentage share to total urban population has gone upto 32.5% in 1991 and is expected to cross 35% in 2001 a d (Table 1).

Teble 1 : Growth of metropolitan cities in india

Year	No. of Metro cities	Population (in million)	as % to total Urban population
1981	12	41 67	26 00
1991	23	70 66	32 54
2001*	40	114 64	35 00

* Projected by the Expert Committee appointed by the Planning Commission India

Source Census of India 1981 & 1991

Calcutta is one of the primate cities and second largest city in India according to the 1991 census. All metro-cities in India are found to dominate the sphere of national economic, social and political changes Calcutta (being largest city upto 1981) has a great role in trade and commerce, industrial economy and it is the centre of socio-cultural diffusion of the state as well as the entire eastern India. Though since Independence population growth rate of Calcutta has been reduced considerably (Table 2).

Table 2 : Decadal growth rate of calcutta and C.M.D. and percentage of calcutta's population to C.M.D.

(Pop.in million)

Year	C.M.D.'s Pop	Growth rate	Calcutta's population	Growth rate	C.M.D. Calcutta	Growth rate	% of Calcutta Pop to C.M.D Pop
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1921	2.25	—	1.05	—	1.20	—	47
1931	2.54	12.93	1.22	15.94	1.32	25.67	48
1941	4.31	69.48	2.17	77.43	2.14	62.12	50
1951	5.14	19.25	2.70	24.50	2.44	14.01	53
1961	6.83	32.37	2.93	8.48	3.90	59.13	43
1971	8.22	20.35	3.15	7.57	5.07	30.00	38
1981	9.95	21.41	3.30	4.95	5.68	31.75	33
1991	12.07*	17.31	4.39*	33.03	7.68	14.57	36

*Projected by the Planning and Development Deptt. Govt. of West Bengal

Source: Census of India 1921 - 1991.

The absolute figure itself is gigantic and if we consider the population of Calcutta metropolitan district (C.M.D.) stretching over an area of 1350 sq.km., it bears the heaviest population load in the state (Table 3) as 65% of the urban population of the state in 1991 resides in the C.M.D. alone, areal extent remaining same, which reflects unchanging scenario of dependency of Calcutta. The basic task is to keep the city environment sustainable and not to pollute further. The recent paper has analyzed the environmental situation of the city at

present and the causes responsible for environmental degradation and tries to search for the possible strategies of improvement.

Table 3 : Share of population of C.M.D. and calcutta to west bengal urban population

(Population in million)

Year	Pop of W Bengal	Urban pop of W Bengal	% of (3) to (2)	C M D pop	% of (5) to (3)	Calcutta pop	% of (7) to (3)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1921	17 47	2 52	14 4	2.25	89	1 05	41 65
1931	18.90	2 90	15 3	2.54	88	1 22	40 65
1941	23 23	4 74	20 4	4 31	91	2.17	45 69
1951	26 30	6.28	23 9	5 14	82	2.70	43 00
1961	34 93	8 54	24 5	6 83	80	2.93	34 39
1971	44 31	10 97	24 8	8 22	75	3 15	28 72
1981	54.58	14.45	26 9	9 98	69	3.29	22.81
1991	67 98	18 62	26 5	12.07*	65	4.39	23 58

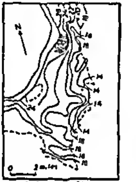
*Projected

Source: Census of India 1921-1991

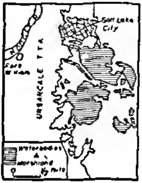
2. History of Growth of Calcutta and genesis of environmental degradation:

Initially a place on the levee of the eastern bank of the river Hoogly was chosen for locating the fort of Calcutta with he idea that the water barrier of the Hoogly river will keep the colonial traders safe from the invasion of the Marathas and Mugs. the fort (Willum) was further fortified by a dug out canal which is known as "Maratha ditch". This very location of Calcutta outlived its purpose and has proved at present to be disadvantageous for the growth of the city. The location is the "raison de etre" of most of the environmental problems. Even a writer of 1880 a.d. remarked that "its situation is so bad by nature that man can do little to make it worse."[3] This locational problem need to be explained to some extent.

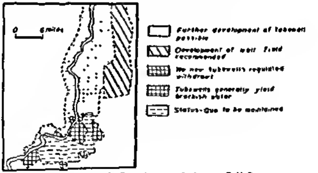
The general slope of deltaic Bengal and Calcutta in particular is from north-west to south-east (map 1). Calcutta being located on the eastern side of the river Hoogly surface drainage channels never get a



Map 1 Calcutta - Slope



Map 2 Calcutta - major water bodies



Map 3 Groundwater situation in C M D

gravity pull to discharge into the river. On the contrary, the slope compels the drainage water to travel all the way from the levee to the salt lake marshes and fogs, located in the south-eastern low land.

Not only the direction of slope, the degree of slope is unfortunately so gentle that it hardly offer any gravity pull to the discharged water The highest contour of 6.5 m. is found to be around College st and Vivekanenda Rd. area and almost imperceptible slope is found on the either side of this area. The western side lowers upto 5 0 m whereas in the eastern side the level comes down to 3 5 m. On the east, near Jadavpur side the contour comes down to 1.5 m.[4] All these reflect the nearly flat terrain of Calcutta which offers no help to the drainage congestion during monsoon and creates water logging problems

The saucer shaped depression of the city landscape'[5] heavy downpour within a short span of tima (1600 M. within 2-3 months), slow seepage of water due to tha presence of an impermeable top clay bed of 9 to 16 m. thickness and deltaic situation with high ground water table only accentuated tha problem and creates the deplorable physical environmantal situation.

During the establishment of Calcutta tha prematura reclamation of Sundarbans (naar Calcutta's southern fringe) for agricultura and colonisation had rendered tha natural outlets including Piyali-Didyadhari system Ineffectiva.

When these are the physical and natural constraints from the beginning, Calcutta faced lack of proper planning which is must for a town to sustain over time. It is otherwise an unplanned city which appeared to have been built with "irregular streets of dusts etc."[6] As the Britishers' interest to develop Calcutta was mercantile in nature and not to develop it as a native city, a sharp difference is found in the plan of settlement development of a large area occupied by the native people and a small pocket resided by the British ruling class. Whatever better planned housing and living condition were found were restricted to the areas of residence and business centre inhabited or managed by the Britishers. The racial segregation is conspicuous in all accounts of architectural documents [7]. At the same time parasitic absentee landlords who used to enjoy luxurious city life, exploiting rural people, did not have any progressiva role in development of Calcutta.

3. Scenario During the 20th Century:

When Calcutta was flourishing as a gigantic labour market, people started coming to the city and settlement started expanding towards

east and south eastern side. The colonisers did not show any interest to control landuse and settlement development in these areas This resulted in totally unplanned and haphazard development of settlements and encroachment or normally uninhabitable marshy land.

The picture of land and settlement development of that time had been revealed beautifully from the contradictory comments of Lord Curzon and E.P. Richards, the first Chief Engineer of C.I.T. When Lord Curzon in a letter in 1903 commented " Calcutta is in reality a European town, set down upon Asiatic soil and it is a monument; in my opinion, one of the most striking extent monument to energy and achievement" E.P. Richards stated that very few Europeans who lived in calcutta possess any knowledge of dense blocks that comprise three-quarter of the city's urban builtup Calcutta has no street system, it would require the creation of 110 miles of ordinary 30-40 feet streets to bring Calcutta into line even the old built-up sections of the other European city and continued that in a third of central Calcutta he found nothing but a slum with 250,000 people living in condition unfit for human habitation [6] Though initially migration was mainly due to pull factor of Calcutta's labour market., later on migration was mainly because of push factors like recurring floods, famine, drought, lack of irrigated land, pressure on decreasing arable land due to increasing population, ill developed secondary and tertiary sectors etc. This helped just to increase the number of slum or pavement dwellers the number of which is not known exactly.

As the Britishers did not have any intention to develop Murshidabad, Dacca and other centres which had better geo-political situation all types of facilities - educational, medical, administrative and institutional - got concentrated in Calcutta, whereas other centres were deprived of. As a result, not only job seekers but also people to have better educational and medical facilities used to have a tendency to come to Calcutta and try to have a residence in and around Calcutta. It is in Tagore's language concentration of blood of the whole body on the face.

Migration and urbanisation have a high positive correlation. The growth of population in C.M.D. in general and Calcutta city in particular have a long history of migration. Upto 1961 Calcutta was a migrant city. 53% of total population being migrant population. In 1981 it declined very sharply being 28%. In 1961 major chunk of population in Calcutta was refugee population comprising of 18% of total population which in 1981 got reduced to only 7% (table 4).

Since Independence when economy of Bengal and particularly Calcutta started deteriorating day by day, tremendous population influx created a critical situation in the seventies As the core city is already saturated, the impact of population pressure fell more and more upon the normally unhabitable land of the fringe areas in the eastern and southern side. Side by side unscrupulous trade in land housing by land developers and the state government without following rules and regulations has created tremendous immediate and long term damages which is threatening the existence of Calcutta itself.

Table 4 : Life time migrants to West Bengal and the districts of Calcutta, Howrah and 24 Parganas. (Population in lakh)

Place of birth	West Bengal	Calcutta	Howrah	Hugli	24 Parganas
1 Total pop					
1961	349 26	29.27	20 26	22 31	62 81
1981	545 81	33 05	29 67	35 58	107 30
2. Migrants					
1961	54 95	15.41	4 18	5.00	14 35
1981	55 85	9 28	3 62	5 87	21 85
3 % of (2) to (1)					
1961	15 75%	52 65%	20 60%	22 4%	22 85%
1981	10.23 %	26 10%	12 20%	16 5%	20 35%
4 Born in the state / other districts					
1961	—	3 10	1 33	2.07	3 09
1981	—	2.23	1.57	1 64	6 80
5 Born beyond the state / (Bihar, Orissa, Assam, U P)					
1961	20 83	5 32	1.85	1 38	2.62
1981	19 50	3.69	1 34	1.45	3 63
6 Bangladesh					
1961	30 63	5.23	0.30	1.31	7.87
1981	32 91	2.22	0 52	2.46	10 74
7. % of (6) to Pop of Calcutta					
1961	—	18 0%			
1981	—	7 0%			

Source : Census of India 1961 and 1981

4. Environmental Situation in Calcutta and its surroundings:

The population growth has tow fold effects on the city of Calcutta and its surrounding areas: tremendous increase in unplanned development of normally uninhabitable lands; encroachment of water bodies, ponds and lakes mainly in the eastern side of Calcutta (See Map 2). This fact is noted by C.M.O.O. also.[9]

The wetlands which are considered to be the outlets of drainage and areas of solid waste and sewage disposal (as mentioned earlier) offers a unique components in urban ecosystem in nutrient recovery and recycling, riching excess nitrogen, inactivation of phosphates removing heavy metals, toxins, chemical suspended matters and silt. The silt called "detritus" offers ideal niche for micro-organisms to act as decomposer and thereby offer habitat for consumers like crustaceans, fishes and birds,.about 8000 tones of fish come to the market of Calcutta from this area making it one of the most effective ecologically balanced sewage disposal systems. The outflow from the sewage-fed farms in the salt lakes are utilised in the irrigation of agricultural areas Simultaneously the garbage disposal area of Dhapa has become vegetable farming area. The organic matter in the garbage which decomposes into compost makes the land fertile for producing several varieties of vegetables simultaneously throughout the year. This area supplies about 150 tones of vegetables everyday and 20% of the vegetables is supplied to Calcutta This area also is now under the threat of usurpation by urban land sharks.

The supply from the exceptionally productive fisheries that catered to the Calcutta fish lovers is now being replaced by imports from other areas raising fish price. It has also deprived the local people of major livelihood.

As mechanical sewage treatment plant could never function in this city the sewage treatment by means of sewage-fed fisheries in these wetlands offer an excellent cost effective natural bio-treatment of waste. Destruction of natural wetlands in the salt lakes. Dhapa and adjoining areas would further damage the ecosystem, alarmingly reducing the capacity of the area to absorb the city's air pollution etc. Over the years with the decrease in amount of waterflow in Bhagirathi-Hoolgly river withdrawal of groundwater is increasing In order to augment water supply system through a grid of 235 tubewells and 6500 handpumps: added to this process is a further daily withdrawal by hundreds of multi-storied buildings which operate privately-owned deep tubewells. Two major difficulties followed. firstly,

while northern part of the Calcutta Metropolitan Area(C M.A) aquifers rendering the tubewells and distribution system quite inoperative due to incrustation. Secondly, indiscriminate withdrawal of groundwater through deep tubewells particularly to meet the needs of multi-storied buildings led to the creation of a "deep valley" in groundwater conditions which increases the cost of withdrawal of water seriously, affecting the supply itself on a long term.

Experts in the field indicate two possible repercussion (a) water famine and (b) danger of subsidence because of the creation of imbalance in the top layer of the earth (as occurred in U S A Thailand and China).

From public point of view, the perennially stagnant drains and sewage disposal system, devoid of a natural outfall helped in the increase of vectors causing gastro-intestinal diseases, malaria and other such debilitating maladies. This is in addition to the distress and epidemic potential, caused during monsoonal water logging and floods particularly in the poorer eastern settlements. Along with this it should be mentioned here that Hoogly river is declared nationally as the most polluted river and the treatment facility along the long distance transportation through Tala has not yet ensured safe drinking water to any part of Calcutta City's health statistics show that 64% of the diseases in the city are water borne and 80% of tap end samples lack any residual chlorine.

These problems coupled with shrinking green belt, traffic congestion, alarming noise and air pollution which are considered to be very normal now-a-days has created serious environmental problems and this metropolis is in serious crisis.

5. Environmental Planning Issues : Probable solutions:

Now sitting over the dormant volcano of environmental disaster, the planner should think how fast they can do something to arrest environmental degradation and make this city more inhabitable. Being a rational citizen we must explicitly announce here that urbanisation and urban development has come out of social necessity So we cannot stop it but we have to think how rationally we can go for symbiotic urban development. This can be done with an integrated plan to undertake longterm as well as immediate measures which are as follows-

(1) Decentralization of administrative and other facilities of the city: Excepting those administrative functions which can sustain distance and time should be decentralised Moreover Calcutta being situated at the southern corner of the state other towns providing all facilities of Calcutta in terms of education, recreation, health etc should be developed

According to some experts quite a good prospect of satellite township in Baresat-Jagulia area on the eastern part of Barackpore and further groundwater and existing roads and railway connections, which is already undergoing development process Another 70 Km stretch of land is lying from Howrah to Saktigarh along the railway chord line. This area after a proper survey can offer not one but a series of planned satellite townships with change of use of marginal agricultural land. there is another area, located beyond north of Dum Dum towards Kalyani-Haringhata This suggestion can further be sustained from the fact that already considerable investment has been made in establishing communication network in the form of BFP Expressway and other trunk roads

Availability of vast potable groundwater supplies in the region is an added advantage. This development process as envisaged can also invigorate the logical development of Kalyani Some experts are also of the opinion that present Haringhata milk system can be transferred to eastern Calcutta with the advantage of needing much lesser distance to reach the consumers. This will create a green belt situation.

(2) Sponsored and statutory controlled growth of the city northward and westward: This can do away many of the infrastructural problems (See Map 3) that are gradually rendering the city uninhabitable (See the appendix). [10]

(3) Prevention and conservation of the salt lake and other water bodies in the eastern and southeastern side arresting further encroachment: Considering the total situation the Government should prepare a development plan with the vision of future urbanisation in next 20 to 25 years and to impose rigid land use control so adequately provided by the T.C P.A (Town and Country Planning Act) in making this directional change.

(4) Checking of cityward migration: Migration from villages to the city should be checked to reduce encroachment of land and water bodies This can be done (a) with a sound urban decentralization

policy at the state level and (b) the Government should take initiative to increase the productivity of agricultural land and employment opportunity of the people who are struggling with the disguised unemployment. If this happens then poor people will not go to the city in search of their livelihood just to create "urban accretion".

(5) Checking of population growth with the help of economic and educational-cultural development in slum areas: The slums (home of the rural migrants and job seekers and the poor artisans, involved in the informal sector of the economy) are the breeding grounds of most of the environmental problems. They are found everywhere in the twin city of Calcutta and Howrah, except in the newly planned areas. The bustees, of course, vary from the city core to the periphery only in size and in the degree of environmental problems. But most of them suffer from insanitary conditions and create health hazards not only for the bustees themselves but for the whole city life. These bustees are inhabited by the economically weaker section mostly in kuchha houses, ill-ventilated and structurally weak. In fact, social and economic deprivation of the people particularly in the slums and high unemployment load have crippled the urban economy. So the productive base of the metropolitan economy which is stagnant in nature needs to be revitalized by a feasible package of economic and industrial development programme.

Analysis of intra-city population growth shows that rate of population increase in slum areas is very high compared to the other developed areas with better environmental conditions. The population increase is negatively correlated with the educational-cultural level and economic development. The government would do better it, instead of carrying out only propaganda of bio-medical means, it adopts the educational, cultural and economic upliftment in the city in general and in the slum with specific emphasis to check the population growth

(6) Mass consciousness regarding environmental problems: The morale of the people has been lowered because of frustrated urban living and as a result they have also lost the civic sense. So they are to be made aware of the environmental problems through various programmes and motivated to tackle them

At last it can be said that the metropolitan expansion towards the fringe area has to be ecologically balanced with the conservation of the wetlands and resist urban encroachment which will ultimately alter the ecosystem. The urban development and maintenance is a crucial

social decision in the planning process and organising the landuse pattern in C M.A.

APPENDIX
Problems and Prospects of Calcutta's Growth

Sl. No	Parameter	East and South Eastern Growth	Northward Growth
1	2	3	4
1	Environmental consideration	Loss of wetlands increases air pollution Destorys valuable ecosystem & waste treatment facility	The wetland ecosystem remains intact
2	Drainage, Flood cushioning and hsealth	Reclamation and urban constructions cause major loss of rainage outfall basins lesser facilities for disposal of rainfall excesses, increases health hazards.	Wet land facilities in the En metropolitan fringe can be utilised for healthier environment
3	Water supplies	Increasing mineralisation and hardness of water unpredicatable salinity in ground water Consequent need to tap and treat Hugli water	Prolific ground water supplies major basin lesser pumping costs and mineralisation problems (only Iron removal called for), safe and potable for humans
4	Sewage treatment and solid waste management	Natural Dhapa system being loss by relcamation Calls for very costly treatment plants Gradual loss of grabage disposal sites as well.	Natural facilities retained Addtional systems can be designed in En. metropolitan fringe wetlands
5.	Economic product	Rich fish haul as primary source of protein rapidly dwindling vegetable growing areas shall also be usurped for urban construction ultimately	Fisheries development can be further strengthened with state/panchayat control More vegetable mixed farming products

1	2	3	4
6	Hinterland & communication	Away from city's hinterland increased freitage and communication/traffic problems in core Calcutta	Nearness to hinterland easier disposal of heavy vehicles Utilisation of trans-Hugli facilities Shall need strengthening of north communication corridors.
7	Social factors	Loss of primary sector livelihood (fisheries farming etc) increasing tertiary sector problems Control by speculators to take care over claimed land parcels at the middle and lowere economic classes.	Distance from core shall discourage such speculators Cleaner urban land development Healthier due to lesser drainage congestion lesser preventivehealth costs etc. Greater land water based employement in primary sector
8	Hugli conservancy	Larger extraction of water for urban supplies with consequent flow reduction and increased pollution and salinity In turn escalating cost of treatment	Tapping Hugli avoidable Northwards reach of river lesser polluted with lesser tidal salinity
9	Land availability	Only by reclama. tion at high cost and degradaton of system.	Good lands available in Kalyani Haringhata zone Dairy be shifted to east Calcutta reclaimed zone

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15

ENVIRONMENTAL PERSPECTIVE OF NARMADA PROJECT AS PERCEIVED BY A BIOLOGIST

Prof. S.D. Sabnis

The Narmada Project or the Sardar Sarovar (Navagam Dam) project, is located about 100 Kms east of Baroda. It is famous, controversial and by far the most ambitious multipurpose project.

The project which has come to the present stage after a tribunal award is still running through rough weather on various counts. Submergence and loss of forest lands, rehabilitation of the ousters, economic viability of the project, seismicity of the area and the religious sentiments of the people are some of the people are some of the major issues on which a loud debate has ensued between the antagonists and protagonists of the dam resulting into a lost of noise, in which the rational approach has been totally drowned. If we accept that for better and a more purposeful human existence, environment and development must go hand in hand it is necessary that every major human intervention in the natural processes be assessed in terms of its environmental impact. Large dams are such interferences which turn a free-flowing river system into a multilevel lake mode with obvious eco-environmental impacts involving all physical and biological parameters. The Navagam dam or the Narmada project in Gujarat is one such venture which has been studied in greater detail than any other similar project in India.

Before we proceed to discuss the environmental aspects it is essential for us to understand, Gujarat's compulsions. Gujarat needs to develop broad agro-industrial base for the economic welfare of not only the vast population within the state but also for the country's forward leap into the 21 st century. If one restricts his travel in Gujarat to the rail corridor between Bombay and Ahmedabad, one is likely to conclude that Gujarat is a very prosperous, affluent state and has no problems of poverty, ignorance and unemployment. Although the

affluent corridor is a reality, there are many other stark realities which are disturbing and need attention.

Gujarat State, located on the west coast of India, has its northern and some portion of western boundaries continuous with he deserts of Rajasthan, Thar and Pakistan. The rainfall varies form 100 mm to 400 mm in the northern and north-western part and from 1600 mm to 2500 in most of the southern parts and that too only during short span of monsoon. Such a low and erratic pattern of rainfall distribution brings irrigation and power generation in sharp focus. In spite of organised irrigation development over the last three decades, a mere 16 percent of the gross cropped areas is irrigated. The reason for this is mainly geographical. All the major perennial river systems of the state are concentrated in the southern and central regions which also receive heavy to medium rains. More than 70% of the ground water resources have been vigorously tapped. Thus the emphasis and onus of supplying irrigation facility are on the development of surface irrigation. Power needs too for the state are increasing by leaps and bounds. Farms and factories have to be continuously supplied with power to keep pace with the tempo of industrialisation and domestic consumption in this progressive state which boasts of enterprise, entrepreneurial skills and leadership. No just accumulation but generation of wealth has been the motto of the people of Gujarat.

Dam construction and impoundment of water for irrigation and power generation thus become essential features towards amelioration of state's economy and realisation of the dreams of its vast population.

The eastern parts of the state comprise the intermittently hilly regions of the Aravalli, the Vindhyas and the Satpuras inhabited by an Adivasi tribal population, poor, innocent and ignorant. Their living condition can best be described as below subsistence; poor in nutrition, education, skills and money. These people depend largely on forest products and the incomes generated by seasonal migrations to nearby cities for labour. They practice extensive but most primitive form of agriculture. Even the hill slopes and tops are cleared to practice scratch agriculture. The productivity of these operations is so low that the tribal population is not able to meet its food or fuel requirement. A vicious cycle has, thus, set in; the low-productivity forests with insufficient resources have not been able to support the burgeoning tribal population and the continuous long-term demand of the large population has resulted into large-scale destruction of the

forests and allied ecosystems. The biodiversity of the flora and fauna including the wildlife of the area has suffered grave losses. The run-off from these areas has increased and since the rains are confined to barely three months of monsoon, the drought conditions have become sharper. Famines and scarcity loom large in the face. What are we then trying to preserve? Is it the tribal culture of their poverty?

The northern or the north-western regions are not as under-developed as the eastern tribal belt, however lack of water has served as an effective impediment to development of area's agriculture and industry. There is a large, nomadic, cattlegrazing population which uses many of these areas for grazing without extending any effort to take care of a support the natural grasslands of the area In times of drought, these human and cattle populations are pretty close to famine conditions requiring investment of crores of rupees for their subsistence The 1986 scarcity conditions in the state cost the country Rs 600 crores, a fact worth remembering while assessing the merits of any developmental project proposed the State. Quite often, the cattle and human populations of the north shift to southern parts of the state where there are better fodder and water resources These recurrent migrations have resulted into number of ecological and socio-economic problems.

The development strategy of Gujarat, thus, calls for conservation and use of monsoon rain water, which otherwise goes into the sea in a relatively shortime. The Gujarat Government has constructed a number of small, medium and large dams and provided the much-needed water to the parched lands Without going into a debate of small v/s big, it can be said that care has been take to plan things depending upon the specific need of the region and the state without in any way losing sight of the environmental issues involved. The construction of multipurpose large dams on the major rivers of the state has generated considerable economic activity in the state. The Ukai dam on Tapi in South Gujarat constructed at a cost of rupees 60 crores in the 1960s is now responsible for a thriving rupees 300 crores per year sugar industry in the south Gujarat region. Such an economic boost is not without its ecological backlashes Proper Resource Management is the answer to all our problems created by unplanned and erratic resources exploitation.

The Narmada is the largest river of Gujarat in terms of water flow. It is also a major interstate river that drains. Madhya Pradesh and Maharashtra besides Gujarat Investigations of the Narmada valley

water resources and power development began in 1947. A dam site at Gora in Gujarat was proposed for which the foundation stone was laid by the then Prime Minister, Pandit Jawaharlal Nehru in 1961. These development plans have been subjected to many revisions partly due to technical consideration but largely due to interstate disputes. The Narmada tribunal gave its final and binding decision in 1979 and the planning for the new project in the light of tribunal's award was started in 1979-80. In 1982, the Narmada Planning group of the Narmada Development Department commissioned a short-term, bench-mark study to assess the probable negative and positive impacts of the Navagam dam and the Sardar Sarovar on the ecology and environment of the downstream and upstream areas in Gujarat. This research was undertaken by a team investigators from the M.S. University of Baroda. The report first published in July 1983 paved way tor a clearance from the Government of India both from the environmental angle and the torest angle as requirad under the forest conservation act, in 1987. The planning commission cleared the project in 1988. Thus the Sardar Sarovar Project with tha proposed terminal dam at Navagam in Gujarat saw the light ot the day practically after four decades of perseverance and untiring efforts. And yet the opposition to the dam continues on one pretext or the other. Even as the dam is being built and making rapid progress, objections to its construction have been vociferously stated and virulent agitations are launched to stall tha construction ot the dam or failing which to reduce its height. Although it is not intended or necessary here to launch a counter offensive, it is felt necessary to give a glimpse ot our efforts to study the environment of the Narmada valley in Gujarat with a view to involving strategies tor proper management of the people in the area and the wildlife which is having a precarious existence in some remote interior forest areas of the Shoolpaneshwar sanctuary.

The 160m high dam at Navagam wilt lead to the formation of a large man-made lake 215 km long with an average width ot 2 Km and maximum width of 16 km. Nearly 220 villages will be totally or partially submerged in the lake. Nearly 60,000 people will have to leave their homes in search of new ones. It promises more than 1400 MW of electricity. It is to have an extensive canal system reaching the thirsty arid areas of north Gujarat, Kachchha and Saurasthtra. The main canal is like a man made river nearly 90 m broad at the head and 450 km long with a discharge capacity of 40,000 cusecs. It will provide irrigation to nearly 18 lacs ha. of cultivable land. Even the ratio of submerged lands to lands benefitted is pretty favourable as compared

to similar projects elsewhere in India. The projects is estimated to cost over 6406 crores of rupees. The creation of the main canal virtually amounts to diversion of Narmada partially to begin with but almost total during tha stage II of the operation. Positive impacts of such a large-scala development activity are too obvious to be enumerated Rather thesa havo 'lured' the State Government to accept e very heavy financial burden. A pre-project 'Environmantal Impact Analysis' is not possible at this stage when the State Government has already snuck a few hundred crores into this project. This essentially is a fait accompli end mitigation only can be the redeemable feature

Developments is e must for the well-being of the Society and the Nation; environment is equally essential for the quality of human life. The humen society must now learn to live with negative impacts of development. In fact, science and technology heve to combine to mitigate the damages due to development and thereby pertly avoiding the head on collision between the environmentalist or the eco-fundamentalists end the developmentetists.

Some such efforts have been made over the yeer by the M.S University research team. In 1983, it came out with a bench-merk study highlighting not only the positive impacts (which are too obvious) but also the various negative impacts in the upstream and downstreem ereas as elso in the command area. The various negative impects highlighted included reduction of weter flow, formation of shoals in waterbeds, salinity ingress, loss of hilsa fishery, industrial effluent discharge in the downstream river, salinization and water-logging unfavourable crop pattern changes in the command erea; end the submergence of forest lands, loss of diversity in flora and tauna, displacement of large, tribal populations in the upstream of the river. The group then made and 'Environmental Impact Statement' after weighing all the negative end positive features and suggested critical areas for in-depth studies and continuous monitoring. The group, since Nov. 1989 has been concentrating on the ecology and environment of the submergence and catchment areas with a view to evolving both scientific and administrative management strategies for the welfare of the people in the area and survival of the last remnants of wildlife in the region. The research project, now in its final phase of operation, has three main thrusts–

> The biological inventory mainly concerned with rare and endangered plant and animal species and attempts at their in situ and ex situ conservation and propagation.

The biomass studies to highlight distribution of productive systems as an aid to salvage and monitor the existing wildlife and

Restoration and enhancement of the ecosystem following tenets of the newly evolving field of 'Restoration Ecology'.

The project, thus is designed to develop enhancement plans and management strategies for eco-systems of the area, 20 Km on each side of the Sardar Sarovar in Gujarat as well as for the extended Shoolpaneshwar Sanctuary in the vicinity of the Sardar Sarovar and Karjan Dam reservoirs. An optimal management of these eco-systems is expected to yield improved and longer performance of the dam projects.

The area under investigation comprises nearly 1600 sq kms. in which a wida essortment of eco-systems exist. They ranga from thick forests to denuded hills, from organised agriculture in plains to scratch agriculture on steep hills and from forests honeycombed with human interferenca in which soils show incipiant to mild erosion pattems to aeverely denuded soils with the unproductive rocky phasa as the dominant feature.

An eco-system classification suitable for these arees was developad as a part of the present effort; it is based on prevalent land usa pattem and also takes into account degree of human intarference and erosion pattems of tha area. The criteria of the eight grades of the classification have been stated and explained previously. Seven of these grades are concerned with varying proportions of forestry and agriculture and other non-forest uses of the land, grade 8 is reserved for areas in which organised agriculture is practiced. The project teams travelled throughout the area and graded the existing eco-systems. The rosults were placed in a map of the area prepared in the scale of 1 : 50,000 and superimposed with a network of 1,6000 grids; each covenng an area of one sq km. The same map and grid network were used to randomly select 160 sites for detailed studies of biomass, floristics, insects, amphibians and birds, and to locate sites at which biological specimens of special interest were collected. Thus it was possible to correlate different parameters of the eco-systems with each other and to analyse the complex relationships, and linkage with greater degree of confidence

Biological Inventory build-up with a view to locating rare and endangered plant or animal species and suggesting measures for their

in situ or ex situ conservation and propagation has been our important function. 50 field trips amounting to nearly 2000 man days hava yielded a rich haul of 520 higher plant species with a few rara or interesting ones. Phytochemical screening, ethnobotanical Information, tissue culture studies heve been Initiated on some of them. May interesting animal species (205 invertebrates and 160 vertebrates) hava been recorded.

Biomass studies to chart out distribution of productive systems, forage availability and forage preference studies, location of water holes hava been particularly useful in predicting wildlife movement so essential for proper management. Thus academic interlinks are established with our collaborating group specialising in a wildlifa management. Plant-animal interactions, food chains, pollinators fruit and saed dispersals have been closely looked at not only for a propar biological perspective but also to get a deeper insight into strategies for restoration and enhancement of the entire system in tha years ahaad.

Our study area is divisible into three distinct sub areas; physiographically and functionally-

1. Extended Shoolpaneshwar sanctuary on the left benks,
2. Right bank catchment Area of Sardar Sarovar (RCAS) &
3. Right bank Extended Area (REA).

Each one of these three has distinctive features demanding appropriate management strategies. We are busy developing an integrated management strategy and plans for the area.

It is obvious that the group has generated a broad database. It should thus, enable the group to come up with management strategy and action plans, which have by now reached an advanced critical stage. Inputs from various courses are being sought to make the plans acceptable to the man in the eco-system.

It would ba proper for me to outline the conceptual understanding and the framework with which the group has all along been working.

The group does not support any forcible eviction; but it looks upon local migration of small groups of population as normal. It would encourage such migrations in search of better quality of life. It looks seriously at only those developmental options likely to wean away people from the primitive core. It fully understands the necessity of caution at every step. The group's plan on human activity reinforces

trends that are already under all similar situations but certainly in the present area. It is imperative that these options are not brushed aside under the pretext of administrative or bureaucratic convenience.

The group strongly objects to people's participation or the rural developmental plans in wildlife management, particularly in the primitive core of the sanctuary. It assumes and probably quite correctly that e legally notified sanctuary like the Shoolpaneshwar sanctuary has to be managed as one.

Human beings can be moved or resettled, of course, after a great effort; same is normally not possible in case of wildlife. Shoolpaneshwar Sanctuary as at present represent shrinkaga of habitat and certainly the last ray of hope for the wildlife. It is also the last bastion of a biosphere that still shows the remains of once thriving admixture of Northern Continental and Southern peninsular animal and plant species. Although the big carnivores or the big and small herbivores are not frequently sighted being rare, the area boasts of interesting amphibians, insects and birds which needs sincere conservation efforts. Interesting plant species also deserve similar consideration. Human intervention, in a big way, is certainly to destroy the fabric of natural systems.

The group egrees with the world bank model of development and zonation of wildlands. Tha microzone model of sanctuary management as proposed by some agencies is nothing but e shameless compromise. The remnant microzones are themselves products of excessive biotic and human interference. To organise every conceivable human activity around these microzones is a sure way of destroying the system earlier than expected. Wildlife protection is the only goal for the sanctuary. Tourism as a sanctuary goal comes in at a very lata stage.

After an eco-system classification into 1 to 8 ecogrades, the entire sanctuary area is sought to be organised into zones such as the primary scientific zone, the natural recovery zone, the buffer zone, the administrative zone and the tourism zone. Human activity, in a big way, is also permissible in some zones. These zones are flexible in conception. Their expanse may change but their interactions and therefore the functions remain fairly unaltered.

All the different strategies or various combinations of them will have to be worked out at the microlevel. The group is presently working on this aspect. Besides the philosophical 'right of living' for the

wildlife, the role of Shoolpaneshwar sanctuary as a means of soil stabilization through improved vegetal cover to increase the life of the dam and the reservoir seems to be overlooked or not properly understood.

The group has an integrated management plan for the entire region. Shoolpaneshwar sanctuary and its people are inseparable part of the whole system. The group intends launching on projects for micro-level planning in the downstream areas and the command areas always with the idea of mitigation of the adverse impacts of the Narmada project. It believes that unplanned development can bring about destruction sooner or later but planned development should mean a profitable, prosperous and peaceful co-existence with nature.

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PHYSICAL ENVIRONMENTAL STUDY OF RESIDENTIAL AREA OF UJJAIN CITY THROUGH AERIAL REMOTE SENSING

B.S. SOKHI, P.S. BEDI AND N.D. SHARMA

1. INTRODUCTION

Environment is a very vast subject which involves a multitude of disciplines for making a comprehensive study, because environmental impacts are felt both at macro and micro levels. In the context of Urban and Regional planning, environment has three main aspects physical, socio-economic and cultural. Under the broad spectrum of physical environment, its three main components, land, water and air, have direct bearing/impact on the physical planning process. Hence residential environment as a part of 'physical environment' has been taken up as a specific study of Ujjain city of Madhya Pradesh.

2. UJJAIN CITY - THE STUDY AREA

Ujjain city situated on the bank of sacred river Kshipra, is one of the seven significant religious centres of India. The city is located at 23°10' N latitude and 75°50' E longitude with an average elevation of 510 mts. above mean sea level (Fig.1). The population of the city as per 1991 census is about 367,000. The areal coverage of city is 28 sq km. Ujjain like any other ancient city of India has a typical characteristic of mixed landuses coupled with narrow zig-zag streets/roads pattern, densely built-up and over populated residential areas, with lack of amenities/facilities in most of the areas.

3. OBJECTIVES OF THE STUDY

The following objectives were formulated for this study:

1. Preparation of landuse map of the city.

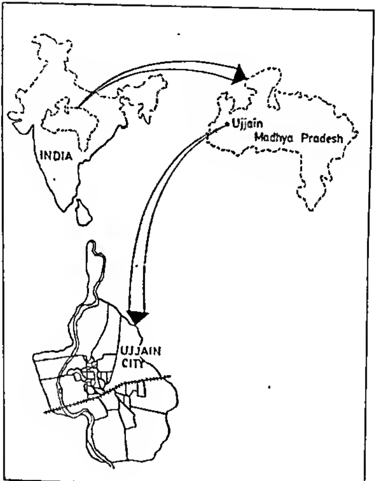

Fig. 1 Location Map

2. Indetification and delineation of some specific activities in the residential built-up area -'visible' through air-photos and 'non-visible' ones by field survey.
3. Selection of environmental sample areas from landuse map.
4. Delineation of impact zones of specific environmental parameters.
5. Preparation of an Environmental matrix.

4. SCOPE/LIMITATIONS OF THE STUDY

1. The study is confined to air-photo interpretation technique - a basic tool to assess the physical aspects of residential environment.
2. Scale of air-photos being 1:15,000 made difficult to delineate some details.
3. Time was definitely a constraint, because the study period was limited to 3 months.

5. DATA PRODUCTS USED

1. Aerial-photogrephs of 1:15,000 scale
2. Photomaps of 1:4000 scale
3. Topographical map of 1:50,000 scale
4. Field survey data
5. Secondary data (from Town planning Dept.,M.P., Ujjain Development Authority, Municipal Corporation - Ujjain).

6. METHOD OF STUDY

This study was carried out in following stages:

a) For the study area measuring 1360 ha., the aerial photographs of 1:15,000 scale were scanned and then the landuse classification (Fig 2) was designed.
b) For identification and delineation of landuse classes, a minimum delineation unit of 1000 sq. mt. measuring 30 mt. X 30 mt. on ground which corresponds to 2 mm X 2mm on the 1:15,000 scale air-photos was selected. The narrow contiguous commercial strips along main roads/streets containing residential space use on upper floors have been taken under dominant residential use.

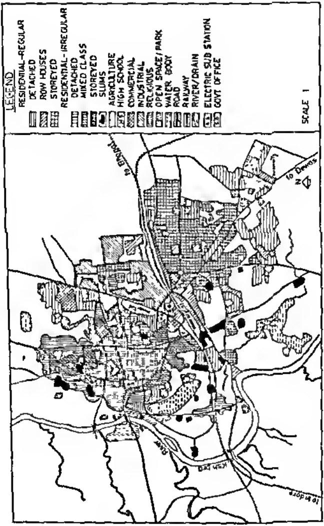

FIG 2 LANDUSE MAP OF UJJAIN CITY

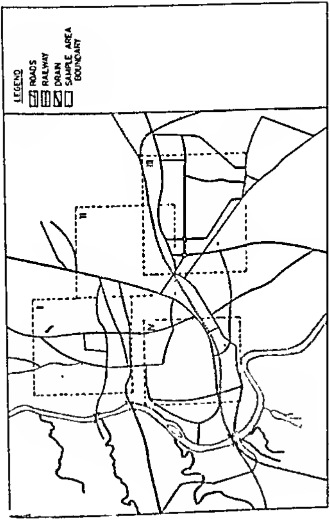

FIG 3 ENVIRONMENTAL SAMPLE AREAS LOCATION

c) Interpretation was carried out under mirror stereoscope and overlays were prepared for each stereo-model. Then information from overlays was transferred to 1:10,000 scale base map. This interpreted landuse was carriad to field to check the doubtful cases and for updating.

d)From this updated landuse map (Fig 2) four Environmental Sample Areas were selected (Fig 3), representing different urban characteristics combinations described here.

6.1 ENVIRONMENTAL SAMPLE AREAS

Since the study is confined to evaluate the quality of certain physical aspects of residential environment of the city through certain chosen physical and environmental parameters, keeping in view time constraint, only four environmental sample areas, large enough to represent the following different characteristics of tha city were selected (Fig.3):

1. Environmental Sample Area I : Measuring 135 ha. represents irregular residential area of the old city in the north.
2. Environmental Sample Area II : Measuring 127 ha. represents regular and irregular mixed residential area with predominant industrial use which is confined to north-east of city.
3. Environmental Sample Area III : Measuring 147 ha. on south-east of city, represents regular (planned) residential area.
4. Environmental Sample Area IV : Measuring 180 ha on south-west towards river Kshipra represents sparsely developed residential area, a mix of irregular and regular residential areas, slums, stagnant water bodies and large extent of vacant undeveloped land.

e) From these sample areas following Environmental Parameters were selected

6.2 ENVIRONMENTAL PARAMETERS CHOSEN

Based on positivity and negativity of the parameters available in the area following parameters were chosen

Negative Parameters

- Polluting Industries
  (Smoke as well as noise)

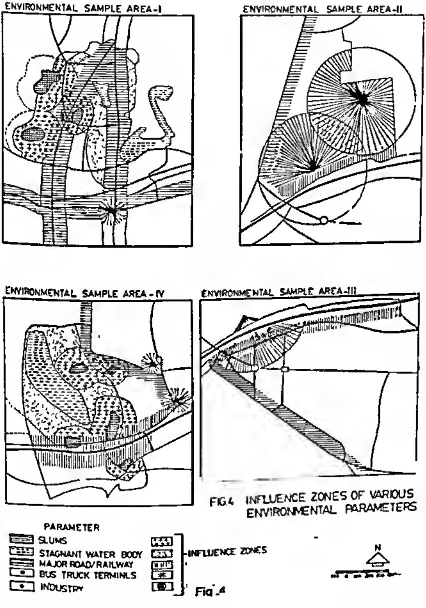

FIG.4 INFLUENCE ZONES OF VARIOUS ENVIRONMENTAL PARAMETERS

Fig.4

- Bus & Truck Terminal (unplanned)
- Major Traffic arteries/road
- Railway yards
- Slums
- Stagnant water Bodies.

Positive parameters are those which enhance the quality of residential environment, while negative parameters lead to deteriorate the quality of environment.

f) On the basis of criteria laid down in Table:1, for determining in fluence zones, the sieve maps (Fig 4) showing the cumulative effects of Environmental parameters on residential areas for each sample area were prepared. This was done by creating the data base using USEMAP GIS software package. All the parameters with digitized first and then influence zones were created with *TORAS programme. These individual parameter influence zone* maps were combined together using COMBINE programme. A sample of computer output for Environmental Sample area III is shown in Fig. 5. The landuse distribution in each sample are is shown in Table:2.

Table-1 : Impact Zones For Environmental Parameters

Sl. No	CAUSE	MEDIA	EFFECT	IMPACT ZONES (in metres)
1	2	3	4	5
1	Major Road	Flow of heavy and mixed auto-traffic	**Air pollution:** —Auto-exhaust (CO_2 & other hazardous gases) — Suspended solids **Noise Pollution:** — Air borne noise — Structural vibration (Medium intensity)	100-150
2	Railway Yard	Shunting of Goods/passe-nger trains	**Air Pollution:** —Smoke-coal dust/ ash fall, Smog formation in winter	150-200

1	2	3	4	5
			Noise Pollution : — Air borne noise —*Structural Vibrations* (High intensity)	
3	Truck/Bus Terminals (Unplanned)	—Movement of Goods/auto traffic —parking of Goods/auto traffic - —Movement of passengers	**Air Pollution:** —*Auto-exhaust* **Noise Pollution:** —Air -borne noise —Structural vibration (Medium intensity) **Traffic Hazards** — Road bottlenecks and congestion — Accidents	100-150
4.	Slums	-Dilapidated Structures -Stagnant water due to lack of drains & sewage	**Visual Pollution:** — Psycho impact on surroundings **Water Pollution:** —Mosquitos & other Disease breeding	150-200
5.	Stagnant water body	*Stagnant water - Garbage dumps* site within catchment area or in nearby pits	***Water Pollution:*** —*Mosquitos* & *other* disease breeding — Contamination of subsoil water —Contamination of drinking water sources. —Foul odour/smell	300-400
6.	Industry (Non-Chemical)	-Exhaust from Chimney stack - Movement of heavy machines	Air-Pollution: —Smoke-Coal/ash fall —Smog formation in winter. Noise pollution. —Air-borne noise —Structural vibration (Medium to *high intensity*)	400-500

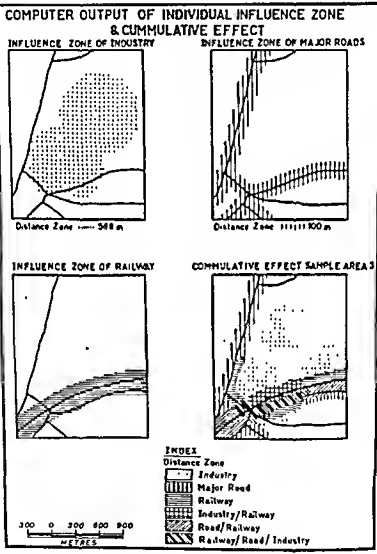
COMPUTER OUTPUT OF INDIVIDUAL INFLUENCE ZONE & CUMMULATIVE EFFECT
INFLUENCE ZONE OF INDUSTRY
INFLUENCE ZONE OF MAJOR ROADS
Distance Zone
Distance Zone 100 m
INFLUENCE ZONE OF RAILWAY
COMMULATIVE EFFECT SAMPLE AREA 3
INDEX
Distance Zone
Industry
Major Road
Railway
Industry/Railway
Road/Railway
Railway/Road/Industry
300 0 300 600 900
METRES

FIG. 5

Table 2 : Land uses in Environmental Sample Areas (in Ha)

LANDUSE		SAMPLE AREA							
		I		II		III		IV	
		AREA	%	AREA	%	AREA	%	AREA	%
1.	RESIDENTIAL REGULAR								
	Detached	-	-	16	12	09	06	20	11
	Raw Houses	-	-	07	06	03	02	04	02
	Storeyed	-	-	09	07	69	47	05	03
2.	RESIDENTIAL-IRREGULAR								
	Detached	31	23	-	-	-	-	14	08
	Row Houses	21	15	-	-	-	-	24	13
	Storeyed	35	26	-	-	-	-	-	-
3	SLUMS	07	05	-	-	-	-	08	04
4	COMMERCIAL	07	05	-	-	08	05	-	-
5	INDUSTRIAL	02	02	52	41	-	-	-	-
6	WATER BODY	02	02	-	-	-	-	21	12
7.	OPEN SPACE	07	05	23	18	13	09	-	-
8	ROADS	19	14	18	14	41	28	11	06
9	VACANT LAND	-	-	-	-	-	-	66	37
10	CULTURAL/ RELIGIOUS	04	03	-	-	04	03	07	04
	TOTAL	135	100	127	100	147	100	180	100

G) On the basis of sieve map (Fig 4) an Environmental Matrix (Table 3) was prepared. This shows the combined influence of concerned physical environmental parameters carrying adverse effects on residential environment of sample area I, II, III, IV respectively.

7. ANALYSIS

The analysis of Environmental Matrix indicates that:

i) In Environmental sample area I, cumulative effect of influence areas of water body, slums, major road and bus terminal is 123 ha

Table-3 : Environmental Matrix

Sl No	Environ-mental Parameter	Sample Area No.	Residential space use							Commercial space use	Influence Zone of each parameter/sample area			
			Regular Area			Irregular Area			Slums					
			D	RH	ST	D	RH	ST			I	II	III	IV
1	Major Traffic	I	-	-	-	15	13	23	-	-	51	-	-	
		II	07	-	-	-	-	-	-	-	-	07	-	-
		III	05	03	11	-	-	-	-	-			19	
		IV	-	-	01	-	13	-	01	02	-	-	-	17
2.	Railway Yard	I	-	-	-	-	-	-	-	-	-	-	-	-
		II	-	01	-	-	-	-	-	-	-	01	-	-
		III	01	04	04	-	-	-	02	01	-	-	18	-
		IV	11	-	03	06	02	-	04	-	-	-	-	26
3.	Truck/Bus Terminal (Unplanned)	I	-	-	-	-	-	02	-	-	02	-	-	-
		II	-	-	-	-	-	-	-	-	-	-	-	-
		III	-	-	-	-	-	-	-	-	-	-	-	-
		IV	-	-	02	-	01	-	-	-	-	-	-	03
4	Slums	I	-	-	-	06	10	06	-	-	24	-	-	-
		II	-	-	-	-	-	-	-	-	-	-	-	-
		III	-	-	-	-	-	-	-	-	-	-	-	-
		IV	08	-	01	-	06	-	-	-	-	-	-	15
5	Stagnant water	I	-	-	-	10	19	12	01	05	47	-	-	-
		II	-	-	-	-	-	-	-	-	-	-	-	-
		III	-	-	-	-	-	-	-	-	-	-	-	-
		IV	03	-	02	01	03	-	03	-	-	-	-	12
6.	Industry	I	-	-	-	-	-	-	-	-	-	-	-	-
		II	14	06	02	-	-	-	-	-	-	22	-	-
		III	-	07	07	-	-	-	-	04	-	-	18	-
		IV	-	-	-	-	-	-	-	-	-	-	-	-
AREA OF EACH RESIDENTIAL SUB-CLASS UNDER CUMULATIVE EFFECT		I	-	-	22	33	42	43	01	05	124	-	-	
		II	21	07	02	-	-	-	-	-	-	30	-	-
		III	06	18	24	-	-	-	02	05	-	-	55	-
		IV	22	-	09	07	25	-	06	02	-	-	-	73
TOTAL AREA			49	25	35	40	67	43	11	12				282

D=Detached, RH= Row Houses, ST= Storeyed

and singular effect of each parameter over-shadows 51, 02, 24 and 46 ha. of residential area respectively.

ii) In the Environmental Sample area II, cumulative effect of industry, railway yard and major traffic road are influencing 30 ha. of area and singular effect of each parameter is affecting 07, 01, and 22 ha. respectively.

iii) In the Environmental sample area III, commutative effect of industry, railway yard, major traffic road are affecting 55 ha. of area and individual effect of each one is adversely affecting 19, 18 and 18 ha. respectively.

iv) In the Environmental sample area IV, singular effect of each parameter over-shadow 17, 26, 03, and 09 ha. respectively. The cumulative effect of water body, slums, major traffic roads, railway yards and truck terminal are influencing 70 ha. of residential areas.

From the above inference, it can be concluded that cumulative effect of environment is highest in sample area I, followed by second highest in area IV, low in area III and lowest in area II

Total population and dwelling units effected by these parameters are shown in Table:4.

Table 4 : Population and Dwellings in Sample Areas

SAMPLE AREA	AREA ha	RESIDENTIAL AREA ha	POPULATION	POPULATION DENSITY	DWELLING UNITS	D.U/ ha
I	135	94	71 150	530	10,300	57
II	127	32	9500	75	1700	13
III	147	81	55 750	330	9700	66
IV	93*	75	57 450	620	9050	104

* Although, Environmental sample area IV measures 180 ha., yet actual built-up area of 93 ha. has been adopted for computation after excluding the vacant land and water body

8. CONCLUSIONS

1. Environmental sample area - I is predominantly irregular residential in use with low percentage of open space/roads. Environmental sample area-II is predominantly on industrial use with high percentage of open areas and less road space. Environmental sample area - III is a regular residential use with balanced proportion of open space and roads and Environmental sample area - IV is having mixed residential uses, but with high

percentage of vacant land, less road space and virtually non-existent of open space.

2. Population density and housing density, both are highest in are-IV, high in area- I, low in area - III and lowest in area II, this indicates over-crowding and congestion In Environmental sample area-IV and I, which reflects poor residential environment in these areas and better living conditions in Environmental sample area- III and good in area-II. As per general standards of any development plan, a population density of persons/ha. is considered low land between 250 to 500 medium, while those which are >500 persons/ha. are high.

3. From the Environmental Matrix, it can be concluded that cumulative effect of environment is highest In sample area I, followed by second highest in area IV, low in erea III and lowest in erea II.

4. In this study aerial remote sensing played an important role. Aerial photographs Interpretation technique has proved to be very useful end purpose-oriented technique with its time end cost effectiveness in identification and delineation of physical environmentel parameters. But large scale (1:5000 to 1:10,000) photogrephs would have been much more useful for the extrection of more detailed Information.

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PROCESS OF DEVELOPMENT & ECOLOGICAL HABITAT OF TRIBES IN INDIA

MADAN MOHAN

1.1 INTRODUCTION

The Tribal population of India is by and large living in remote areas which are comprehensively backward in terms of social and economic development. On the other hand, tribal territories are rich in natural resources, particularly in minerals and forests. The necessity for exploiting these resources to the benefit of the nation has exposed the tribal areas during the last hundred years or so. The non-tribal groups have largely enhanced these resources, since they are skilled in superior techniques. Moreover, such development has not only brought about a dislocation but also destruction of the tribal forms of economy, way of life, culture and even fragile ecosystem. However, the new technological agencies of development and patterns of source utilisation are largely responsible for disturbing the ecological balance particularly in tribal area such as Damodar-Mahanadi and Narmada-Son basins in India. The pressure on natural resources - the land, water, forest and atmosphere - has been so threatend as also the health and well-being of the people today that each one of the major natural resources has been degraded to an unbelievable level with amazing rapidity. For instance, of the 266 million hectares of land considered productive, about 90 million hectares has been acutely degraded, chiefly on account of a loss of tree cover and top soil. In addition, about 1.3 million hectares of forest is lost almost every year, a good deal of which is located in the environmentally critical zones and the tribal belts. The current demographic trends together with those of livestock indicate the magnitude of the existing and potential burden on environment particularly on renewable and non-renewable resources.

Moreover, the 'Jhum' is often described as a way of life for the tribals. Tribals way of life is imposed by the environment, particularly because maintenance of soil fertility is possible through afforestation. On the other hand, the cultural life of the tribal people has its own evolution centred around 'Jhum'. Animal husbandary is another means of occupation in the tribal regions.. However, to keep the relationship intact two approaches have been recommended with the introduction of the new technology i.e. the modification of 'Jhum' into plantation economy and the forest management (Ramakrishnan, 1985). With these approaches, the relationship between man and nature can be preserved without much distortions. In addition, it is also necessary to create consciousness among the tribal farmers for types of farming best suited to the ecological conditions of the areas of their living The tribal habitat still suffers from relative ecological isolation from other areas. The modern development has not yet entered into the tribals "little world". Their habitat ecology is to be gradually transformed with the help of appropriate technology providing low-cost energy resources to improve their economy; based on locally available resources (Singh, 1986). This will help in the restoration of ecological balance.

The tribal population of India is far from homogeneous from an anthropological point of view. The tribal groups display striking diversity in demographic, economic and ethnolinguistic background. They also betray heterogeneity in their cultural traits and level of social development. The concentration of tribes in the hills and forests and the remote backward tracts largely explains the state of their stagnant economy. They are backward educationally as well as in terms of technological development (Ahmad, 1988). In India, the definition of the tribes has been changing over the periods of time. Some of the scholars even do not bother about the definition of the tribe. They view that "tribe is a tribe which is included in the list of Scheduled Tribes". The ethnic minority is a more appropriate term than pejorative tribe (Pathy, 1989). Some of the noted scholars have tried to present their conceptual views on the definition and characteristics of the tribal way of life. Universally, the tribals are expected to possess some of the following characteristics such as (i) their roots in the soil date back to a very early period; (ii) they live in relative isolation of the hills and forests; (iii) they have a low level of techno-economic development. (iv) their cultural ethos stand out from the other section of the society; (v) the egalitarian and non-exploitative nature of society (Duebe, 1977) In addition to this, the Scheduled Tribes means such races or

tribes or parts or groups within races or tribes as are declared the Scheduled Tribe under Article 342 of the Constitution. In India, during 1991, in all the States and Union Territories, the aggregation of the scheduled tribes or groups of tribes notified together comes to 573. It is discerned that no tribe has been scheduled in the State of Haryana and Punjab and the Union Territories of Chandigarh, Delhi and Pondichery. However, the tribal communities of India display an interesting profile of the country's ethnic diversity. It is, therefore, pertinent to look closely at the general patterns of their spatial distribution in India. Among the ethnic groups of India, the Scheduled Tribes hold a significant position. They belong to different ethnic, linguistic and religious groups and have some unique social and economic characteristics. The tribal communities include major groups like the Bhils, Gonds and Santhals each with a population of over 3 million. Next to them are the Minas, the Mundas and the Oraons, each having a population of more than 1 million people. The Hos, the Khonds and the Kols, each group comprises a population of more than half a million. Then there are 42 tribes each having a population between 1 to 5 lakhs. Thereafter come tribes of small groups consisting of a few hundred each only. All these tribal communities generally inhabit in areas which are by and large unfavourable for settled agriculture. The tribals occupation and way of life are intrinsically linked with the environmental setting of such areas. In India, a convention in respect of tribes stipulated that tribal population should have full benefits of material well-being and spiritual development regarding freedom, dignity, economic security and cultural specificities. But this schedule was not operational in all parts of India as against other parts (Burman, 1989). However, the policies of socio-economic development with due consideration to the problems of tribal areas have been initiated since independence in the country. Efforts have ben made to mend the old mistakes. The future planning looks forward to the social and economic upliftment of the tribal areas. It is expected that these groups will be sharing the fruits of economic development without losing the good qualities of their cultural identity.

1.2 STUDY REGION AND OBJECTIVES

The present research proposes to examine the sate of environment of the tribal population in the context of the Indian sub-continent in order to highlight the major constraints of tribal development in India. The problems and prospects of tribal development have also been considered in terms of ethnic identities and class status as had

been taken into account in different development plans and policies concluded last.

1.3 DATABASE AND METHODOLOGY

The present research is primarily based on the recently published secondary source of data i.e. the census of India 1991, India, Final Population Totals; Brief Analysis of Primary Census Abstract, Series - 1, paper -2 of 1992. For computation of large data for regional analysis, the David Sopher's (1974) the Disparity Index method is well known. In comparison to this, the Index of Gini's Coefficient seems most suitable and is powerful summary Index for measuring the inequality in any distribution. Lorenz's Curve is a commonly used graph to show it visually. The overall concentration found in curve is measured numerically in terms of the ratio of the area under the curve and the line of qual distribution. The area of the triangle is formed by the X-axis and the line of equal distribution (Lorenz, 1905). The ratio of the Gini's Coefficient (G) has been numerically worked out by the following formula (Duncan, 1957):

$$G = \frac{1}{100 \times 100}\left|\sum_{i=1}^{n} X_i . Y_i + 1 - \left(\sum_{i=1}^{n} X_i + 1 . Y_i\right)\right|$$

Where : G = Gini's Coefficient,

n = Sum of the column ' n',

i = Sum of J^{th} row ' 1 ',

XI = Cumulative percentage distribution of the attribute i.e. the total population,

Yi = Cumulative percentage distribution of the attribute i.e. the scheduled tribe population,

E = Summation sign, sigma

On the other hand, a more precise quantative measurement of the degree and direction of relationship has been worked out with the application of the linear correlation (Pearson, 1948) method which is defined as follows:

$$r = \frac{Exy - \frac{Ex \cdot Ey}{N}}{\sqrt{Ex^2 - \frac{(Ex)^2}{N}} \times \sqrt{Ey^2 - \frac{(Ey)^2}{N}}}$$

Where .

r = Coefficient of Correlation,

x = Independent variable i.e. the percentage of tribal population to total population,

y = Dependent variable i.e. the percentage of tribal primary sector workers to total main workers,

N = Number of observations.

Significance test of correlation coefficient has been carried out by degree of freedom (n-2) in the following manner·

$$t = r. \sqrt{\frac{n-2}{1-r^2}}$$

Where :

t = Test of significance for correlation coefficient,

r = Value of coefficient of correlation,

n = Number of observations,

(n-2) = Degree of freedom.

1.4 PRESSURE OF TRIBAL POPULATION AND ITS PATTERNS OF DISTRIBUTION :

In 1961, out of 424 84 million people in the country, a little over 30 million persons or 6 87 per cent recorded as Scheduled Tribes. During 1971 the scheduled tribe population increased to 36 41 million person out of 528.92 million people. Thereafter, in 1981, the numerical strength of Scheduled Tribes grew up to 51.63 million persons, out of 659.30 million people in the Country. They eccounted for 7.83 percent of the country's total population. By 1991 the Scheduled Tribes population rose to 64.88 million persons out of the 816.17 million pressure of the Scheduled Tribes population is also clearly evidenced by the Table 1. The Tribal population growth rate was 21.37 per cent which rose to 23.79 per cent and 25 67 per cent during 1961-71 to 1971-81 and 1981-91 periods respectively. In other words, the tribal

population grew at the rate of about 2.1 per cent per year in the decade 1961-71 and thereafter slightly increased to 2.4 per cent and 2.6 per cent per year in 1971-81 and 1981-91 periods in the country. However, such pressure of tribal population resulted due to the natural growth of population on the one hand and by the additions made to the list of Scheduled Tribes over the periods on the other.

In India, the tribal communities depict a highly uneven distribution between the States due to their strong tendencies of clustering and concentration in the hilly and forested tracts. This is clearly evident by the Lorenz's Curve drawn for 1991 which depicts the state of concentration of tribal population as shown by the

Table 1: Scheduled Tribes Population and Its Growth in India, 1961-1991.

Year	Population (in million)		Percentage of Scheduled Tribe Population	Growth Rate	
	Total Population	Scheduled Tribe Population		Total Population	Scheduled Tribe Population
1961	424.84	29.21	6.87	–	–
1971	528.92	36.09	6.82	24.49	23.55
1981	659.30	51.63	7.83	24.65	43.06
1991	816.17	64.88	7.95	23.79	23.79

Notes:

1. Table excludes the population of Assam and Jammu & Kashmir.
2. Above Table has been compiled based on the Census of India 1991, India, Final Population Totals: Brief Analysis of Primary Census Abstract, Series - 1, Paper - 2 of 1992.

Figure 1. In other words, measures the inequality in the distribution of tribal population in comparison to the scheduled caste population in relation to the total population of the country. A comparative examination of the two curves reveals that the distribution of Scheduled Tribes is relatively more concentrated than that of Scheduled Caste population. The curve for Scheduled Caste on the other hand does not show such a high degree of concentration

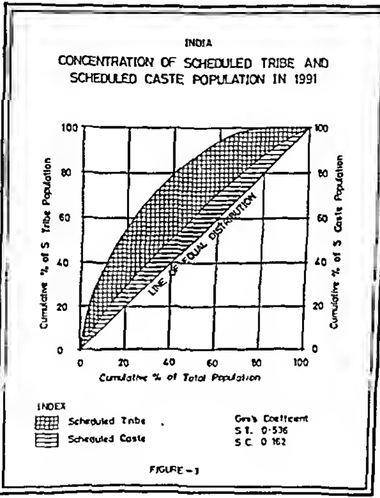
INDIA
CONCENTRATION OF SCHEDULED TRIBE AND SCHEDULED CASTE POPULATION IN 1991
Cumulative % of S Tribe Population
Cumulative % of S Caste Population
Cumulative % of Total Population
LINE OF EQUAL DISTRIBUTION
0
20
40
60
80
100
INDEX
Scheduled Tribe
Scheduled Caste
Gini's Coefficient
S.T. 0·536
S.C. 0·162
FIGURE – 1

Fig 1

However, such comparative scenario of concentration has also been reflected in terms of the computed ratio's of the Gini's Coefficient viz. *G = 0.536 and G = 0.162 for the Scheduled Tribe and Scheduled Caste* respectively. These two values show a relatively higher concentration of Scheduled Tribe than the Scheduled Caste population in relation to the total population. So, the concentration of tribal population may be explained in terms of the geographical, socio-economic and historical perspective as mentioned hereafter. The numerical difference in the spatial distribution of the tribal population is brought out by the Table 2 (See Figure 2). The states and Union Territories with rich alluvial plains favourable to agriculture such as Punjab, Haryana, Delhi, Uttar Pradesh and Chandigarh have either no tribal population or the proportion of the tribal population is negligible. However, the cases of Bihar and West Bengal are slightly different as these States are also mainly situated within the alluvial plain. They support a fairly sizable tribal population In fact, their share is equal to or a little lower than the national average of 7.95 per cent during 1991. A second category of States consists of Goa, Kerala, Tamil Nadu, Karnataka and Andhra Pradesh, most of which are lying on the plateau. In all these States, the percentage of tribal population to total population is quite insignificant.

Table 2 : Per cent Distribution and Decadal Growth Rate of Scheduled Tribe Population in India, 1981-1991.

Sl. No.	India/States or Union Territory	Percentage of Scheduled Tribe Population		Growth Rate 1981-91	
		1981	1991	Total Population	Tribal Population
1	2	3	4	5	6
	India	07.83	07.95	23.79	25.67
1.	Andhra Pradesh	05.93	06.31	24.20	32.23
2.	Arunachal Pradesh	69.82	63.66	36.83	24.75
3	Bihar	08.31	07.66	23.54	13.87
4	Goa	00.07	00.03	16.08	-45.51
5	Gujarat	14.23	14.92	21.19	27.08

1	2	3	4	5	6
6.	Haryana	-	-	27.40	-
7.	Himachal Pradesh	04 61	04.22	20.79	16.69
8	Karnataka	04 91	04 26	21.12	04 96
9	Kerala	01 03	01 10	14 32	22.75
10.	Madhya Pradesh	22 97	23 27	26 84	28 46
11.	Maharashtra	09 19	09.27	25 73	26.79
12	Manipur	27 30	34 41	29 29	62.94
13.	Meghalaya	80 58	65 53	32.86	41 03
14	Mizoram	93 55	94.75	39 70	41.49
15	Nagaland	83 99	87.70	56.08	62.98
16	Orissa	22.43	22 21	20 06	18.89
17	Punjab	-	-	20 81	-
18	Rajasthan	12.21	12.44	28 44 ·	30 88
19	Sikkim	23.27	22.36	28 47	23.47
20.	Tamil Nadu	01.07	001 03	15 39	10 37
21	Tripura	28 44	30.95	34 30	46.14
22.	Uttar Pradesh	00.21	00.21	24 73	23.72
23	West Bengal	05.62	05.60	24 73	24 04
	All Union Territories	01.75	01 71	31 59	28.50

Notes :-

1. Above Table Excludes Assam and Jammu & Kashmir States.
2. Table has been compiled based on the Census of India 1991, India, Final Population Totals: Brief Analysis of Primary Census Abstract, Series - , Paper -2 of 1992, pp. 42 & 44 Maharashtra State is, however, a notable exception, though contiguous to the block of southern States mentioned above. In comparison to the patterns noted above, the central India States of Rajasthan,

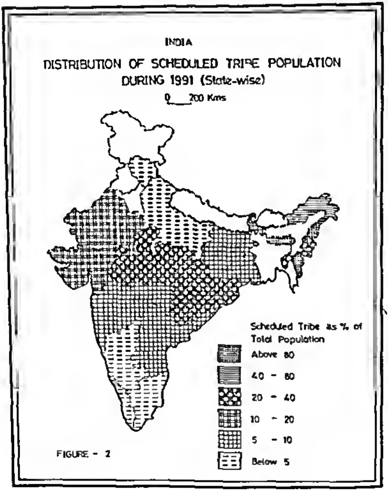
INDIA
DISTRIBUTION OF SCHEDULED TRIBE POPULATION
DURING 1991 (State-wise)
0 200 Kms
Scheduled Tribe as % of
Total Population
Above 80
40 - 80
20 - 40
10 - 20
5 - 10
Below 5
FIGURE - 2

Fig 2

Gujarat, Orissa and Madhya Pradesh, contain a high share of tribal population ranging from 12 to 23 per cent in 1991. In these States the tribal population is not uniformly distributed. They are generally concentrated in the rugged terrains and the forested regions. Among the northern states, the Himachal Pradesh which *is quite mountainous and forested does not* have a high concentration of tribal population. The proportion of tribal population in Himachal Pradesh is quite low i.e. the 4.22 per cent. The North-eastern States presents distinguishing scenario of tribal population of the country. The numerical strength of Scheduled Tribes in these areas is low, whereas their share in the total population is very high. It is generally 70 to 90 and above per cent, particularly in Mizoram, Nagaland and Arunchal Pradesh whereas Manipur and Tripura have a comparatively lower proportion which are 34.41 per cent and 30.95 per cent respectively.

Table 3 reveals that out of 23 states, the tribes have been scheduled in 21 States of the country. In as many as 11 States, the share of Scheduled Tribe population is higher than the share of the total population in 1991 in the country. Significant gap between the share of Scheduled Tribe population and that of the total population is noticed in Madhya Pradesh where almost one-fourth (i.e. the 23.73 per cent) of the Scheduled Tribe population in country has been enumerated. The state which has the second highest share of Scheduled Tribe population is Maharashtra which shares 11.28 %

Table 3 : Per cent Distribution of India's Total and Scheduled Tribe Population During 1981 and 1991.

Sl. No	States	1981		1991	
		Total Population	Scheduled Tribe Population	Total Population	Scheduled Tribe Population
1	2	3	4	5	6
1.	Andhra Pradesh	08 12	06.15	08 15	06 47
2	Arunachal Pradesh	00 10	00 85	00 11	00 85
3.	Bihar	10 60	11 26	10 58	10.20
4.	Goa	00.15	Neg.	00 14	Neg

1	2	3	4	5	6
5	Gujarat	05.17	09 39	05 06	09 50
6	Haryana	01.96	--	02 02	--
7	Himachal Pradesh	00 65	00 38	00 63	00 34
8	Karnataka	05.63	03 54	05 51	02 95
9.	Kerala	03 86	00 51	03 57	00 49
10	Madhya Pradesh	07.91	23 22	08.11	23 73
11.	Maharashtra	09 52	11.18	09 67	11.28
12.	Manipur	00 22	00 75	000 23	00 97
13	Meghalaya	00 20	02.09	00 22	02 34
14	Mizoram	00 07	00 89	00 08	01 01
15	Nagaland	00 12	01 26	00 15	01 64
16	Orissa	04 00	11.46	03 88	10 84
17.	Punjab	02.55	--	02.49	--
18.	Rajasthan	05 20	08 10	05.39	08 44
19.	Sikkim	00 05	00 14	00 05	00 14
20.	Tamil Nadu	07.34	01 01	06 84	00 88
21	Tripura	00 31	01.13	00 34	01 32
22.	Uttar Pradesh	16 82	00 45	17 04	00 44
23	West Bengal	08.28	05.95	08 34	05 87
	All Union Territories	01 17	00 29	01 40	00 30

Notes :-

1. Above Table Excludes Assam and Jammu & Kashmir States.
2. 'Neg ' stands for value less than 00 01.
3. Table has been compiled based on the Census of India 1991, India, Final Population Totals: Brief Analysis of Primary Census Abstract, Series - 1, Paper - 2 of 1992, pp 40. 11.28 per cent of the

of the scheduled tribe population, 9.67 per cent of the total population, in the country. Orissa which shares only 3.88 per cent of the total population has 10.84 per cent of the Scheduled Tribe population in the country. Similarly, against the share of 5.39 per cent of the total population, Rajasthan has 8.44 per cent of the Scheduled Tribe population in country. The States of Andhra Pradesh and West Bengal share 6.47 per cent and 5 87 per cent of the Scheduled Tribe population in the country. In other words, of the total population of Scheduled Tribe, the States of Madhya Pradesh, Maharashtra, Orissa, Bihar, Gujarat, Rajasthan, Andhra Pradesh and West Bengal together account for about 91 per cent of the entire tribal population of the country in 1991 as is evidenced by the Table 3. On the contrary, the States and Union Territories with high tribal percentages have a far lessar share in the country total tribal population. The Tribal population of tha north-eastern States of Arunachal Pradesh, Manipur, Mizoram, Nagaland and Meghalaya together account for 6 81 per cent which is only one-twentieth part of tha total tribal population of India. Consequently, the tribal population is not avenly distributed but it is clustered and concentrated in isolated regions of the country. *Such regional units have a low degree of accessibility* and are generally unfavourable for advanced forms of agriculture. In fact, this leads one to realisa the implication of such a distribution pattern of *tribal population as presented in* the *above text for the* country as a whole.

1.5 SPATIAL GROWTH PATTERNS OF TRIBAL POPULATION

The significant change in spatial distribution patterns in the proportion of the tribat population among states from 1981 to 1991 is brought out and presented in Table 2. As mentioned earlier, the Scheduled Tribes have been enumerated in 21 out of 23 States. Among these 21 States, the proportion of tribal population declined in 9, while 11 recorded an increase and remained the same in one. The sharpest decline is noticed in the State of Arunachal Pradesh where the proportion has declined from 69 82 per cent in 1981 to 63 66 per cent in 1991. Out of the 21 States, the highest increase in the proportion of tribal *population noticed is in Manipur (27.30 per cent in* 1981 to 34 41 *per* cent in 1991), Meghalaya (80.58 to 85.53), Mizoram (93 55 to 94.75), Nagaland (83.99 to 87.70) and Tripura (28 44 per cent to *30.95 per cent). All these States are incidentaly lying together* in the north-eastern region of the country and the proportion of the

tribal population is quite high in each of these States except Manipur. In the remaining States the tribal population proportion increased marginally as is evidenced by Table 2.

A highly uneven pattern of growth (State-wise) of the tribal population is observed in the country during 1981-91 decade as revealed by the Table 2 (See figure 3). Among the States, both Nagaland and Manipur recorded a highly significant growth rate of the tribal population of 62.98 per cent and 62.94 per cent respectively. These growth rates are not only high but more than double the national average of 25.67 per cent. Besides this, other States are Tripura, Mizoram, Meghalaya and Arunachal Pradesh with the rate of 46.14, 41.9, 41.03 and 24.75 percentages respectively in which tribal population growth rate is observed higher than the national average. Sikkim has recorded a growth rate of 23.47 per cent. However, all these states together form the north-eastern region of the country. Besides this, among the centrally located States, the growth rate of tribal population is little more than the average as in the case of Madhya Pradesh (28.46 per cent), Rajasthan (30.88 per cent) and Gujarat (27.08 per cent). The mountainous states in the north i.e. the Himachal Pradesh (16.69 per cent) alongwith the northern plain's states such as Bihar and West Bengal show a growth rate of tribal population below the national average as recorded in the Table 2. In addition, all the southern States except Maharashtra (26.79 per cent), the growth rate of tribal population observed is far below the average. The lone State of Goa recorded a highly negative growth rate of -45.51 per cent of tribal population in the country during 1981-91 period.

1.6 TRIBAL REGION'S ECONOMIC DEVELOPMENT AND DISPARITY

The Tribal economy can be termed as a subsistence economy or a primitive economy. But as a result of interaction building between the tribal and non-tribal population, members of many tribes work as industrial labour. Thus, tribals can be found in India in different stages of economic development. The tribals socio-economic and cultural characteristics are of multi-functional kinship system, egalitarian and non-exploitative nature of society. A large number of tribes have entered the "cultivation stage" while some are still in the transition stage

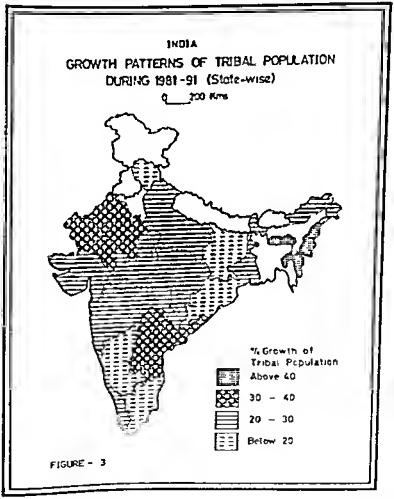
INDIA
GROWTH PATTERNS OF TRIBAL POPULATION
DURING 1981-91 (State-wise)
0 200 Kms
% Growth of Tribal Population
Above 40
30 - 40
20 - 30
Below 20
FIGURE - 3

Fig 3

The rural tribals who constitute the majority still practice 'Jhum' cultivation. In other words, the tribal population is mainly engaged in the primary sector activities as is clearly evidenced by the Table 4 (See Figure 4). In terms of economics, tha primary sector forms the backbone of the tribal economy. In other words, in spite of the practicing of the mining and quarrying activities alongwith the livestock, forestry, fishing, hunting and allied activities, the cultivation activity continues to dominate the other sectors of the tribal economy from 1961 to 1981 in the country. In fact, in 1961, about 91.30 per cent of the tribal workers were dependent on agriculture Among primary sector activities, the proportion of agricultural labourers is considerably lower than the proportion of the cultivators, in the tribal regions of the economy.

Table : 4 Classification of Workers in Different Sectors of the Economy From 1961 to 1981, India.

		1966	1971	1981
1.	Primary Sector.	91.30	93 57	89 93
(a)	Cultivators	68.18	57.57	54 43
(b)	Agricultural labourers	19 70	33 04	32 67
(c)	Livestock etc activities	03 42	02.35	02 25
(d)	Mining and quarrying	–	00 61	00 58
2.	Secondary Sector.	03 49	02.54	–
3.	Tertiary Sector	05 21	03 89	–
		100 00	100 00	100 00

Notes :-

1. Above Table has been compiled based on the Census of India 1971, India, Scheduled Castes and Scheduled Tribes (Table C - VIII, Part A & B), Series - 1, Paper -1 of 1975, pp 98-101; and the Census of India 1981, India, Primary Census Abstract, Scheduled Tribes, Series - 1, Part II - B (iii), pp. 4-15.
2. Figures for 1961, 1971 & 1981 are not comparable because of change in definition of worker.

Table 5 : Distribution of Total Main Workers (Schedule Tribe) by Primary Sector, 1971 and 1981.

Sl. No.	India/States or Union Territory	Percentage of Workers in Primary Sector 1971	1981
	India	60.53	57.26
1.	Andhra Pradesh	40.32	46.15
2.	Arunachal Pradesh	94.94	92.92
3.	Bihar	64 53	65.50
4.	Goa	32.29	29 54
5	Gujarat	49 33	48 65
6.	Haryana	-	-
7.	Himachal Pradesh	88 39	79 70
8.	Kranataka	37.68	45.25
9.	Kerala	26 00	30.90
10.	Madhya Pradesh	63.63	63 56
11.	Maharashtra	*43 08*	*41.81*
12.	Manipur	89 73	87 31
13.	Meghalaya	81.07	76.77
14	Mizoram	87.52	79 62
15	Nagaland	89 80	84 66
16	Orissa	55 57	55.38
17.	Punjab	-	-
18	Rajasthan	84 49	81 86
19	Sikkim	66 21	68 15
20.	Tamil Nadu	55 77	50 26
21.	Tripura	76 60	66.93
22.	Uttar Pradesh	80 71	79 35
23.	West Bengal	43 17	35.17
24.	All Union Territories	65.07	51 66

Notes:-

1. Above Table excludes Assam and Jammu & kashmir States.
2. The proportion of primary sector workers excludes the proportion of agricultural labourers.
3. Above Table has been complied based on the Census of India 1971, India, Scheduled Caste and Scheduled Tribes (Table C - VIII Part A & B), Series - 1, Paper -1 of 1975, pp 98-101 and ; the

Census of India 1981, India, Primary Census abstract. Scheduled Tribes, Series - 1, Part II -B (iii), pp. 4-15.

However, the proportion of the primary sector scaled free with the exclusion of the proportion of agricultural labourers for the country as a whole Such statistical rational conversion of data is helpful in the presentation of comparative scenario of the tribal work force in different regions of the country. About 60.53 per cent and 57.26 per cent of the total main workers are engaged in the primary activities (excluding agricultural lobourers) during 1971 and 1981 periods respectively in the country as a whole, as witnessed by the Table 5 Also, it is noteworthy to mention that the States having high proportion of tribal population also showed high share of workers engaged in primary activities, such comparison can be easily made by the Table 5 and Table 2. Thus, es mentioned earlier the cultivation is now the basic occupation of most of the tribes in India. However, this relationship is not only. Statistically tested but is also proven in the country spatially during 1971 and 1981. The computed result shows that there exists a positive relationship between the percentage of scheduled tribe to total population and the percentage of primary sector workers (excluding agricultural labourers) to total main workers during the 1971 and 1981 periods for the country as a whole The computed values of the Correlation Coefficient are r = +0.649 and r = +0.814 for the 1971 and 1981 periods respectively. These positive values show significant relationship in the States. This is also corroborated by the computed values of 't' which are t = 3.718 and 3 479 and are greater than the tabulated 't' values. These computed 't' values are greater by 1 per cent and 5 per cent and even by 10 per cent of tabulated value of 2.86, 2.09 and 1.73 of 't' respectively. Hence, the correlation coefficient between the two variables is highly significant for both the periods. However, there exists a strong positive correlation at the States level in the country. On the basis of correlation coefficient, it is concluded that the data supports a strong relationship between the variable i e. the scheduled tribe population and the primary sector activities in the country as a whole.

1.7 Conclusion :

The Tribals have been exploited for centuries together by the non-tribals The tribals concentration in isolation from the main civilisation has kept them ignorant of modern institution, scientific and technological development and changing environment. Such cir-

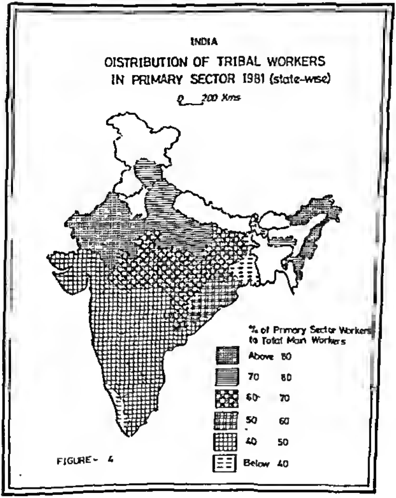
INDIA
OISTRIBUTION OF TRIBAL WORKERS
IN PRIMARY SECTOR 1981 (state-wise)
0 200 Kms
% of Primary Sector Workers to Total Main Workers
Above 80
70 80
60 70
50 60
40 50
Below 40
FIGURE - 4

Fig 4

cumstances have contributed to illiteracy, primitive mode of living and poor resource base of the economy of the tribes.

Many schemes have been initiated for the development of tribal areas in India since Independence. These are broadly grouped into four categories such as (a) communication; (b) education and culture, (c) development of tribal economy and ; (d) health, housing and water supply. Favourable agrarian policy had formulated as well as adopted in tribal areas. In those tribal regions where settled cultivation is practiced, the need has already been stressed on the adoption of new agrarian technological inputs such as the improved seeds, fertilisers and better implements etc. Likewise, in those tribal regions where shifting cultivation or the 'jhuming' is practiced attempts have been made to bring up the fertility of the 'jhum' areas, on a scientific basis. So, the colonization schames have been introduced in the tribal regions i.e. tha Tripura and other states in the east, Kerala in the south and in the central part of the country. In some tribal areas of tha country, mechanised raclamation of hilly and forested tract is being carriad out. In tribal areas of tha Rajasthan State positive responsa have been obtained in successfully adoption of the new agrarian technology, especially in adoption of high yielding varities (HYVs). Apart from this, tha tribals have been lived in the mineral rich resource ragions for centuries although without knowing about them. For instance, tha Munda tribes inhabits in the mineral rich resource regions for centuries although without knowing about them. For instance, tha Munda tribes inhabits in the mineral rich Chotanagpur plateau of India. The industrilisation is considered and played a vital role in the economic development Some important major industries were also located in tribal areas such as the Rourkela, Ranchi and Bokaro steel plants. These have provided considerable employment opportunities to tribal people as unskilled labour. But the process of industrilisation has caused a large scale displacement of the tribals on the one hand and tribal life is getting disintegrated on the other. However, programmes for developing and promoting of cottage industries based on locally available resources are to be formulated at large scale which would help in subsidiary occupations among the tribal people such as the animal rearing, weaving, sericulature etc Marketing facilities are also to be provided for such products consumption. Apart from this, many tribal areas are still isolated from the rest of the country. So, it is necessary to provide adequate infrastructure as the roads, transport and other means of communication to be helpful in assimilation in the national economy. Besides this,

while preparing the tribal regions sub-plans, needs of the area are to be taken into consideration e.g the variety of problems of the tribal areas and communities at different levels of socio-economic development. In addition, the sub-plans implementation should give specific importance to the most backward tribal regions. Such developmental policies to be able to bring closer to the main stream of national life. However, in order to correct the existed age-old barriers, it is necessary that the new policy should visualise tribals region as individual part of a larger ecological frame with which they have inextricable linkages. It is irrational to consider them in isolation of the ecological and spatial context. Consequently, no doubt since independence efforts have been made to ameliorate the tribal people's economic and social conditions. It is, however, unfortunate that most of the tribals have not only remained neglected but also exploited a lot in spite of the specific safeguard provided in the Constitution for the protection and advancement.

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18

SOLAR ENERGY FOR COOKING : A Strategy

Geetha Susan Philip & Sathyajity Mathew

Cooking accounts for the major share of energy consumption in developing countries. In India, 88% of the energy consumed in the house hold sector is for cooking[1]. At present we are depending mostly on coal, gas, fire-wood and cowdung to meet our cooking needs. Due to the pressure of our ever increasing population rate, energy requirements in this sector is expected to be increased in the coming years. On the other hand fossil fuels are running out and its reserve will be completely drained out in the near future. Another dimension of this problem is the environmental fuels. These organic materials, when burned, will produce many pollutants like fly ash, ash, oxides of carbon, sulphur and nitrogen and other particulates. Using fire-wood for cooking has resulted in drastic reduction of forests, there by creating severe ecological problems.

Hence it is high time for us to find out an early available alternate energy source for cooking which is non-depletable, and non polluting Here comes the significance of tapping solar energy for cooking As we are richly endowed with this inexhaustible abundant source of energy, solar cookers have a promising future in supplementing our domestic energy needs. Efforts to harness solar energy for cooking stated right from the fifties and resulted in the development of various versions of solar cookers This paper reviews some of the strategies.

BOX TYPE SOLAR COOKERS.

The simplest version of box type cookers consists of an insulated hot box, having two trays, one inside the other (fig.1). Space between the trays is filled with glass wool for insulation. Inner side of the hot box is painted black for energy absorption A transparent window, consisting of two glass panes spaced 2 cm apart forms the top lid of

the hot box. An edjustable mirror fitted at the lop reflects the incident solar radiation into the hot box thus enhancing its performance Materials to be cooked are taken in shallow blackened containers and

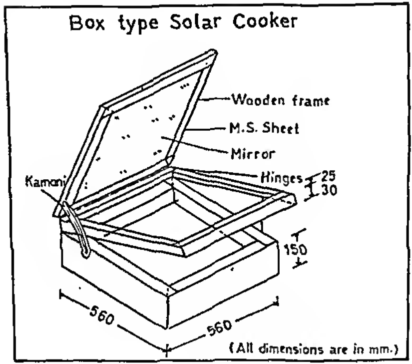

Fig 1

placed inside the box. In an average sunny day, cooking can be carried out in 2-3 hours. Time for cooking different items using box type solar cooker, in a field trial is given in table 1.

Several attempts are made to reduce the overall construction cost of box type cookers. In one model outer box was made with high quality corrugated cardboard and inner box with aluminium foil Space between the two is filled with waste paper for insulation. It uses a rectangular glass as cover and an aluminium foil as the reflector[2]. In another version, box is made with clay bricks and the absorber plate is

replaced with black stone Performance of both these models are reported to be encouraging.

Cookers with inclined surface and width to length ratio more than unity are recommended for areas with lower ambient temperature, since this will reduce the edge effects. To enhance the performance further, cookers with linear multistep assymetric concentrators are developed. These concentrators have two mirror reflectors fixed at an angle with each other. After incorporating these modifications, the cookers are reported to have a concentration ratio 2.0 where as the conventional design have concentration ratio around 1.2.

In order to eleminate the effect of fluctuations in the sunshine cookers operating in dual mode-solar & electric - are developed. When solar intensity is dropped. These cookers will switch to electricity. When intensity reaches the desired level, electric supply will be *automatically cut off and it will go back to the solar mode.(5 & 6)*

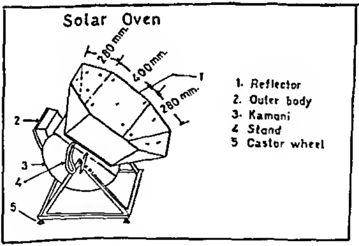

Fig.2

SOLAR OVENS

Owing to the high concentration ratio-as high as 3.5 solar ovens are found to perform well even in areas of low sunshine. These ovens consist of a trapezoidal mirror assembly, to focus the radiation in to the cooking chamber (Fig .2). The wooden cooking chamber is cylindrical in shape and has a double layer glass lid Inner side of the chamber is painted black and the food to be cooked is kept in a blackened vessel which is placed on the platform hanging inside the chamber

Table. 1 : Time taken to prepare different food materials

No.	Item	Quantity(kg)	Time (hours)
1.	Rice	1	1 50
2.	Boiled rice	1	2 50
3.	Pulses	1	2 50
4.	Tubers	1	1 25
5.	Meat	1	3 00
6.	Fish	1	2 50

Table 2 : Comparative performance of Box type solar cooker and solar oven

No	Time (hours)	Ambient temp (°C)	Temp Inside oven (°C)	Temp Outside Box Cooker (°C)	Solar Intensity (Kw/m^2)
1	9	24	88	63	0 52
2.	10	31	117	85	0 64
3.	11	33	132	108	0 70
4	12	35	151	119	0 80
5	13	34	163	120	0 78
6	14	33	158	117	0 74
7	15	30	153	103	0 62

The whole structure is supported by angle iron stand mounted on wheels and can be adjusted to face the sun while cooking. Test results of a solar oven on no load and its comparison with a box type cooker is shown in Table 2.

SOLAR BASKETS.

The sun basket invented by Dr. Von Oppen of ICRISAT is an efficient low cost solar cooker made out of locally available materials. It's construction is so simple that, any body with a little ingeunity can fabricate it (Fig. 3). It basically consists of a parabolic reflector made up of a bamboo basket lined with papeir mache, Papier mache is

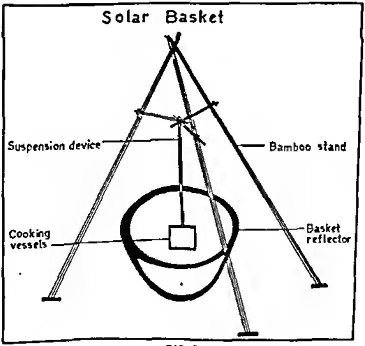

FIG. 3

Fig 3

made by boiling to pulp a mixture of 3 kg paper waste, 3 kg methiflower and 2 kg wheat flower. This pulp is pasted over a parabolic mould in 1 cm thickness and is covered with a bamboo basket for reinforcement. After drying, the whole structure is taken out of the mould and the inner surface is lined with silver paper, thus forming the reflector. The basket is fixed on a bamboo frame, with the reflector facing the sun. The blackened cooking pot is fixed at the focussing point of the reflector. Cooking is reported to be very fast 5 metres for coffee, 20 metres for chicken, 20 metres for rice etc-with the sun baskets.

PROBLEMS AND PROSPECTS

Although solar cookers have become regular features of the kitchens in some developed countries like Israel, response received from Indian house-wives is not encouraging. According to the recent statistics of DNES, total number of solar cookers installed till March '92 is only 2,27,463[8] which is not a reasonable figure for a country like India. Major factors constraining the popularisation of solar cookers are,

1. Cooking has to be performed outside, exposing the house-wife to the sun.
2. Frequent orientation is required especially in the case of focussing cookers.
3. Some dishes like chappathi, fried items, etc. cannot be made by solar cookers.
4. In winter cookers are found to be inefficient, making it adaptable only in summer.
5. Lack of awareness.

However these hurdles can be overcome by R & D efforts and intensive demonstration & extension programmes. The economical (These cookers are expected to save Rs 400/- yeer as fuel cost and have a pay back period of 2-3 years) and environmental benefits of using solar cookers should be projected well in these programmes.

The subsidy extended by DNES at present (Rs 150/- per cooker) is not found attractive It should be enhanced to 50% of the total cost. This can be justified since.

1. The conventional energy sources are also highly subsidised and what we are paying today is only a fraction of the actual cost.

2. The external benefits accrue to the society due to environmental cleanliness, resource management and saving of foreign exchange by reducing import etc. should be shared with the user.
3. As a new and promising technology incentives are required at the initial stage.

Local manufacturing of these systems should be encouraged by providing long term loans and tax benefits. For the wide spread acceptance of any new technology, it should be technically feasible and economically viable. R & D efforts should be more focussed in this direction. In short, if proper policy measures are taken, solar energy can emerge out as a potential energy alternative in Indian house holds, in the near future.

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ENERGY FROM WIND - AN OVER VIEW

Sethy Ajith Mathew and Geethe Susen Philip

Energy is widely accepted as e crucial input in the development process and the per capita energy consumption reflects the economical end social status of a nation. Keeping the developmental thrust in view, energy requirement is expected to be increased sharply in the coming years; as evidenced in fig 1. On the other hand conventional energy sources ere running out and even al todeys consumption level, its reserve will be completely drained out in the coming fifty years.

Tepping energy from todays conventional sources has resulted in severe environmental ill effects. Thermal power stations pollute the atmosphere by loading it with oxides ol sulphur and nitrogen. Large scale hydroelectric projects will result in massive displacement of human population from the project sites. Accidents occurred in different parts ol the world has raised serious public concern egainst nuclear power plants. Similarly burning petroleum and its products lor power generation also have fouling effect on the environment. Along with this, political tampering and constantly escalating cost of fossil fuels, force the man kind to tum his attention to new and renewable sources of energy.

Potential of wind as an alternate energy source can be quantified by its total power capacity of 10^{11} Mega watts around the earth surface. It can also be advocated for its environmentally friendly nature as supported by table.1. Hence successful harnessing of even a fraction of this clean and abundant energy source will be helpful to a great extent in bridging up the gap between the energy demand and its supply.

History of extracting power from wind dates back to the sailing vessels of 4000 BC. Persian wind mills made its appearance by 644 A.D. followed by Dutch wind mills of twelfth century. Since then many versions of wind Energy Conversation Systems were developed in

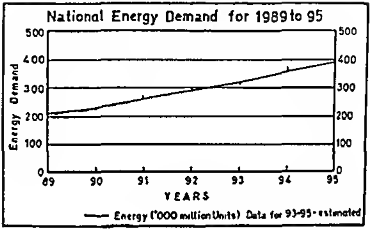

Fig. .1

different parts of the world. Present days wind machines have a rated capacity ranging from few kilowatts to megawatts.

Theory of Wind Power : The power available in the wind is taken as the flux of kinetic energy through the active cross sectional area intercepting the wind mill rotor and can be expressed by

$$P = 0.5 CAV^3$$

Where 'P' is the power, 'C' is density of air, 'A' is active cross sectional area and 'V' is wind velocity. Influence of wind velocity on power produced is evidenced by this cubic relationship. Power contained is a wind stream, cannot be completely extracted out by a rotor. Theoretical maximum efficiency with which a rotor can accept power from a wind stream (usually termed as power coefficient) is only 0 593 (Betz's limit). Hence the theoretical maximum power output of a wind mill will become $0.29\ ev^3$.

Table. 1 : Pollution saving per year from a typical 200 kw wind electric generator

1.	Average Yearly output	400,000 kWH
2.	Substitution of coal	120 - 200 tonnes
3.	Sulphur Dioxide (SO_2)	2.0 - 3.2 tonnes
4.	Nitrogen Oxide (NO_2)	1.2 - 2.04 tonnes
5.	Carbon Dioxide (CO_2)	300 - 500 tonnes
6	Slag and Flyash	16 - 28 tonnes
7.	Particulates	160 - 280 kg

[Source : Ministry of Non-Conventional Energy Sources, 1992]

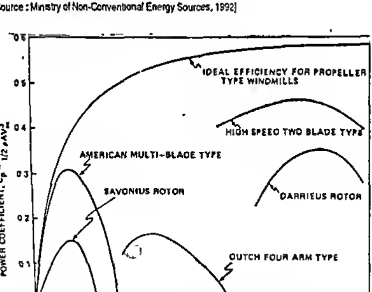

Fig 2 : Typical performance curves of different wind mills

In actual practice the value of power coefficient will roughly vary from 0.15 to 0.45 (Fig 2) depending upon the wind mill type and design features. Again, the efficiency of the energy conversion system also should be incorporated. In short, using the sea level value of density 1.225 kg/m3 available power per square metre area of collecting surface may be roughly estimated to be 1.9×10^{-4} V^3 kilo watts, assuming a power coefficient of 0.4 and generating efficiency 0.8.

The major problem with wind energy is this low power density (comparing with solar radiations) which implies that large machines will be required, especially in low velocity regions.

Another problem associated with wind power utilization is the unsteady nature of wind. Wind characteristics may vary greatly from one geographical location to another. In addition, wind at one site may show large seasonal or even daily and hourly variations is direction and speed. Since the variation in speed results in large changes in the power, every care should be taken in the selection of site and energy storage systems.

Potential Applications :

Mechanical energy out put from wind mills can potentially be utilized for lifting water from wells for domestic use or for minor irrigation Head against which water is pumped will range from 3m to 15m with a seasonal variation of the order of 5m. Considering the low speed of wind mills it is most convenient to couple it with positive displacement pumps which can operate efficiently at these speeds. Rotor speed has to be stepped up when it is connected with rotor dynamic pumps. The excess water pumped can be stored in overhead tanks and can be used in now windy periods. A modem application of windmill water pumping operation involves pumping water under high pressure to Irrigation sprinklers. In another option the water pumping wind mill drives a small air compressor and the compressed air pumps the water. Advantage of this system is that the wind mill can be located at a convenient site away from the well. attempts are also being made to generate electrical power which is then used to operate electrical pumps. Usually high solidity wind mills having low cut in velocity and high initial torque like multibladed horizontal axis and savonius types are used for water pumping. Cut in velocity of water pumping windmills ranges from 2m/s to 3m/s.

In 1890 the first electricity generating wind mill was installed in Denmark. Since then many attempts are being made to utilize wind power for electricity generation.

Both DC and AC electrical generators are available. D C. generated electricity can be used for DC appliance or for battery charging The battery chargers charge the batteries with D.C. power through a voltage regulator and if required, the power is then converted to alternating current through an inverter. For large scale electricity generation, the energy will be in the form of constant frequency alternating current. A typical system will consist of the turbine, speed manipulating unit, Generator, controls and load system Either constant or variable speed generators can be used but constant speed generators are common owing to its simplicity & economy.

For the economic viability of wind electric generation velocity should be in the range of 7 m/s to 10m/s. Usually low solidity wind mills operating at high tip speed ratios are preferred to electricity generation.

The mechanical and electrical outputs from the wind mills can be utilized for a number of operation such as grain milling, water heating with paddle wheels, grain drying etc. But their technical feasibility and economical viability should be weighed before coming to the conclusion about the potentiality.

Status of Indian Wind Energy Programme

In India, scope of tapping power from wind is tremendous, since twenty percent of our land area enjoys powerful wind in the order of 2 5 ms^{-1} to 5.5 ms^{-1}. DNES has estimated the nations wind energy potentials 20000 MW where as studies conducted by Tata Enemy Research Institute Indicated a capacity of 50000 MW. However some recent investigations indicate higher potentiality than these estimates. Wind velocity and power density of some potential sites are given in Table 2.

Nations wind energy programme is mainly Implemented through the Department of Non Conventional Energy Sources (DNES). Present days wind energy programme comprises of assessment of wind resources, research, development and extension of technologies which have a promising commercial future such as water pumping. battery charging and large scale power generation. At present 43 MW eggregate capacity has been established in the country including 6 5 MW in the private sector. Salient features of Indian wind energy

programme is displayed in table 3 & 4. With a view to encourage the utilization of wind energy for power generation, the government has announced several promotional incentives like subsidies, duty free import of specific spare parts, tax benefits, confessional finance etc.

Table 2 : Wind data from some potential sites (Mani *et al.* 1983).

No	Station	State	Wind speed (ms^{-1})	Power density (wm^{-2})
1.	Mandais	Gujarat	6.30	161.30
2.	Kandala	Gujarat	5.90	132.50
3	Okha	Gujarat	5.70	119.40
4.	Tuticonn	TamilNadu	5.60	113.27
5.	Indore	Madhyapradesh	5.30	96.02
6.	Veraval	Gujarat	5.30	90.70
7	Rajkoto	Gujarat	5.10	85.60
8	Coimbatore	TamilNadu	5.00	80.60
9	BhavaNagar	Gujarat	5.00	80.60
10.	Kanyakuman	TamilNadu	4.60	75.90
11.	Keshod	Gujarat	4.90	75.90
12.	Dwaraka	Gujarat	4.80	71.30
13	Dewgarh	Maharastra	4.60	62.80
14	Puri	Orissa	4.60	58.80
15.	Madrasbarbor	TamilNadu	4.50	58.80

SOME STRATEGIC ISSUES

Inspite of the enormous energy potential and Governmental incentives, most of our wind energy projects are in experimental or demonstrational stages. Following points should be given due weighage while moulding up the strategies for commercial power generation

Table 3 : National wind energy programme (source. Ministry of Non-conventional Energy source, 1992)

Total capacity	:	99 MW
Installed	:	36.5 MW (Demonstration Projects) 6 5 MW (Private sector)
Under Installation	:	14 MW (Demonstration project) 42 MW (private sector)
Total WEG installed	:	303 (55-300 kW size)
Generation from demonstration		
Projects during April 92-Aug 92	:	30 38 Million units
Availability of WEGs	:	About 95%
Annual capacity factors under favourable conditions	:	25-30%
Annual Energy generation	:	2-2.5 Million KWH/MW
Average capital cost	:	Rs. 3.00 crores/MW
Average cost of generation	:	Rs 2.00-2 25/KWH
Gustation period	:	One to Two years

Table 4. Status of installation of deep wind pumps (Gear type) in Nos. (Source: Ministry of Non-conventional Energy Source, 1992)

S. No	State	No. Installed	Under Installation
1.	Andhra Pradesh	10	–
2.	Gujarat	–	40
3.	Karnataka	17	3
4	Kerala	15	5
5	Madhya Pradesh	4	16
6.	Maharastra	23	7
7.	Rajasthan	19	1
8.	Tamil Nadu	59	1
9	Uttar Pradesh	4	16
	Total	151	89

Wind resource survey and site selection

Success of a wind energy project greatly depend on the availability of strong wind at the site. Failure of some well published projects like Kottamala project in Kerala is mainly due to the improper site selection. present method of generating data is criticized since it is site specific. Data under the wind mapping and wind monitoring should be integrated with the back up of theoretical techniques so that it can be extrapolated horizontally and vertically with much confidence. Attempts should also be made to identify new windy sites which are not included in the previous nation wide survey.

Cost reduction : Economical viability is essential for the commercial acceptance of any new technology. Hence our R & D efforts should be more focussed on cost reduction without sacrificing the technical feasibility. Possibilities of cost reduction through size scaling up also should be investigated.

Technology upgradation : Most of todays wind energy conversion systems are working only at 70% of the expected efficiency level. Hence efficiency of the systems should be enhanced through R&D efforts. Letest advents in metallurgy should be exploited for the rotor development. Another point requiring immediate attention is the overall weight reduction of the system.

Appraisal of System Performance : Monthly statistics of failures and shut down should be fed back from the sites to chalk out rectification measures for possible failures. Data presently available, in terms of gross annual performance of several systems put together, are inadequate for technology easement.

Developing Indigenous Industry : Today our wind energy programme is depending heavily on imported technical know how. Development of indigenous industry should be stimulated by proper policy measures.

In short, in the coming years wind energy can give — if harnessed efficiently — significant contribution to the goal of meeting our future energy needs through the use of clean, and essentially in exhaustible source of energy.

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TECHNOLOGY FOR ENVIRONMENTAL PROTECTION

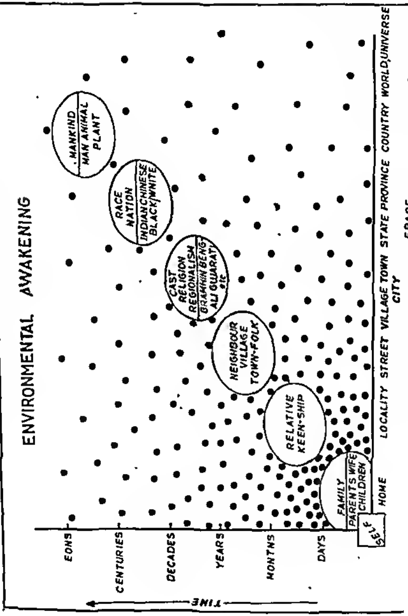
K.C. Sahu

UNDERSTANDING ENVIRONMENT

Environment is a sum total of the physical and chemical factors of air, water and soil often known as the biosphere, in which living things live. For man it also embraces social, cultural, economical and political factors and may be looked upon as the earth-people system.

Consciousness of the environment .known es "Environmental Awakening" stretches in space and time from a living room to the entire biosphere and from every ticking hour to eons (Fig. 1 as modified from Medows *et al*, 1972). However for the mortal man, limited as he is, his environmental consciousness too tends to be limited except in rare solitary individuals in the history of mankind, who might achieve cosmic consciousness or 'enlightenment' of the wholistic environment. Difficult as it is to live up to the ideals of wholistic environment, it is possible to at least think globally while acting locally (Regier 7 Baskerville, 1985). Instances ere many where all technological endeavours have failed where wholistic approach to the environmental problem has not been considered and technological solution to solve a problem has merely brought forward dozens of other problems to the society as a whole such that the primary aim of the technological solution has been relegated to the background.

The total environments is a dynamic system and consists of compartments (Air, Water Land), sectors (Forest, Wildlife and Man) and sub-sector (Society, Industry etc). Natural changes in each compartment, sector or subsector, being slow and non violent the intracompartmental stresses produced therein are automatically balanced by intercompartmental transmission of microscism (Sahu, 1986). The stresses are self balancing and the recuperative forces of



ENVIRONMENTAL AWAKENING
MANKIND
MAN ANIMAL PLANT
RACE NATION
INDIAN CHINESE BLACK/WHITE
CAST RELIGION REGIONALISM
BRAHMIN BENGALI GUJARATI etc
NEIGHBOUR VILLAGE TOWN-FOLK
RELATIVE KEEN-SHIP
FAMILY
PARENTS WIFE CHILDREN
SELF
HOME
LOCALITY STREET VILLAGE TOWN STATE PROVINCE COUNTRY WORLD,UNIVERSE
CITY
EONS
CENTURIES
DECADES
YEARS
MONTHS
DAYS
TIME

nature self cleansing. However, the culture of modern technology having no-self-limiting pnnciple in terms of size, speed and violence and being infinite in scale, discordant to nature as well as discriminatory to sectoral development, results in degradation of the environment as well as in differential accumulation of environmental stresses in compartments and sectors. On exceeding the stress limit, the system ruptures resulting in catastrophe, disaster or tragedy so common in technology dominated modem society. While accumulation of degradational stress can be concieved by analysis of trends and responses, the disasters like Minamata tragedy, Bhopal episode, Ethiopian famine, wars and riots analogous to any lithopheric earthquake (Ex. : release of crustal stress along San Andreas Fault) become apparently cognisable only after its occurrence and the intensity of damage measured in a suitable scale to assign the degree to the catastropha. The tragedy howaver as once rightly remarked by Wilston Churchill is than, man though anxious to look forward, can not look beyond what he can see, therefora falls to read and writings on tha wall lika "Do not eat people, they contain too much DDT".

"STOP, LOOK AND LISTEN" AT TECHNOLOGY

With the discovery of Copemicus the homocentinicity of the cosmic onion (Home, 1978), a myth of the westem philosophy, peeled off and man, as always been proposed by oriental mind tumed into a more insignificant element of nature. No wonder, the concept of western proto-dogma, that man is the centre of the universe and has the god given right to use and abuse "his universe" emerge as modem

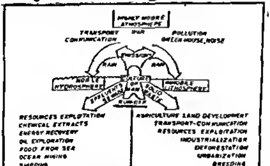


Fig 2 : Inter Compartmental Culture of man
(Modified from Horne, 1978)

technology and grew up into supertechnology, a culture which today permeates the whole environment in the interphase of atmosphere, hydrosphere and lithosphere (Fig.2 modified from Horne, 1978) and has even shot up into extra-terrestrial space.

There is measures in all natural things - in their size, speed and even violence- which makes all natural systems of which man is a part, tending to be self-adjusting. Not so with modern technology or man dominated by technology and specialization which recognizes no self limit. The typical watch words of technology are : more, larger, speeder, further, quicker and richer upto the point of no return (Harrison, Brown, 1958). However in a subtle system of nature, all forms of giantism are antibodies and there are numerous sign of rejection. All violent and discordant adventures of technological achievements till today have been best with nature's checks and balances (Francis Bacon) (Fig 3) and ability to hold the balance of nature in temporary abeyance is never a license to man to consider the earth as his legitimate quarry.

Modern technology by virtue of its mass production, transport and communication and media advertisement- Aldous Huxley calls it "pernicious adult education",- encourages conspicuous consumerism for its own existence leading to a life style where need is taken over by greed. Consumerism is the basic factor behind resources exploitation and resources depletion with resultant pollution and environmental degradation and scanty respect to nature. Instead of surviving on it, apparently man is milking the mother earth (Bahuguna, 1984) In the stampede of resources exploitation- a poor life style indeed. The modern technology has come as a handy tool for this purpose.

There is nothing in the experience of last decades to suggest that the modern technological achievement is really helping us to alleviate world poverty not to mention of unemployment. At the end of every five year plan our employment list is larger, our larger public sector operations are in red without even taken care of consumption of the godly assets, the primary capitals. Already the environment in all sectors is trying to tell us that certain stresses are becoming excessive around centres of large technological ventures. As one problem is being "solved" ten new problems arise as a result of the first solution. The new problems, as Barry Commoner emphasizes, are not the consequence of incidental failure but of technological success. The population growth and migration, the DDT and pesticide accumulation, temperature inversion and carbon dioxide balance, oxygen depletion,

space debris, nuclear waste disposal and lastly the drudgery of drug addiction of our modern youths in affluent technologically advanced society are not failure of technology but products of it. The banner of super technology "Break through a day keeps the crisis at bay" flutters no more. Because the break throughs have broken the back-bone of human civilization since the primary aim of technology is to enhance the quality of the products and devalue the producer to plastic man. In a machine, always the goods are polished and refined but man come out corroded.

To ensure the continuation of modern civilization and ideology upon which our culture is founded, to support an ever increasing world population and to increase the "quality of life" technology in a gigantic scale has been ushered into action. Although the "Doomsters" (Proponents of The Limits of Growth) too now accept the capability of modern technology to extend the Horizon of the "Limits of Growth), the actual "limit" arises out of the "energy crisis" and consequent environmental constraints of the whole ecosystem. It is also noteworthy that in the present form of sectional development, most regions rich in primary resources in this country apparently reel under poverty line while the quality of life is far from desirable in regions (affluent society) having excessiva consumption of resourcas. It is for this reason that "for the first time in man's life on earth he is being asked to refrain his economic and technological advancement or at least to direct it differently from before" (Mihajlo Mosarovia & Eduard Pestal, 1976). It has become necessary to "stop, look and listen" before the next giant technological leap is made. In most futuristic circles such en introspection into supertechnology is not considered to be "a blind objection to progress but an objection to our blind progress".

SEEKING FOR A SOLUTION

Seeking for a solution for environmental protection and conservation in a natural ecosystem where everything effects everything else directly or indirectly, requires a "whollistic approach" (also written as 'holistic') or "system approach" as against "analytic approach" traditionally used in scientific enquiry and technology solution. "You can not do merely one thing" as G. Hardin has put it. A good example is pollution brought about by antipollution devices like the jungles of smokestacks to prevent air pollution in United States and Western Europe, which merely removed the particulates- as a matter of fact isolated the solid particles which used to react with acid gases and

Prepositions have been made in various circles for healing the impact of modern technology and protect the degradation of the environment by what is otherwise known as "appropriate theology" "Technology of head, heart and hand-3H-technology" or "Technology with a human face". It emphasizes that :

1. Workplaces have to the created in areas where people live and not in metropolitan areas into which they tend to migrate.
2. On average, a workplace should be cheap so they can be created in larger number (Small is Beautiful, Schumacher) without large capital investment or imports. For example in steel industry the untenable economic calculus of "a million cupola instead of a million ton cupola" (Sahu, 1986- in press) can thus be pushed into the economy of environmental frame-work in the form of ecological protection. Afterall it is not just coincident that Ecology and Economics have a common root and in Ancient Greek the two words were interchangeable terms and can be done again (Willard, 1978).
3. Production methods should be simpler preferably from local materials and as far as possible for local consumption. Just as modern economy would admit that high rate of consumption of transport services between a man's home and his work place signifies misfortune and not a high standard of living, so also to satisfy human wants from far away sources rather than from sources nearby signifies failure rather than success (Guy Wint. 1966).
4. Use of tools and machines that enhances a man's skill and power and does not make him a slave as in the classic eulogized Adam Smith's Pin Factory (in Wealth of Nation) where the final product can be produced at a great speed without any one having had to contribute more than a totally insignificant and in most cases unskilled movement of his limbs (Schumacher, 1977). This raises the self confidence of the maker and user alike (McGarry, 1985), provides job satisfaction to the "worker", a satisfaction which is never achieved by even the highest paid chief executive of the largest venture in any industry.

With progress and advancement and for an improved quality of life in mind, challenge to environmental degradation and consequent pollution can be met by three distinct style of measures like (a) curative (b) preventive and (c) adoptive or symbiotic living

Curative measures : Technological application of controls like effluent treatment in industrial sectors, filters and precipitators in emissive ducts; large scale industrialization food production and settlement to meet the need of increased population in social sector etc. are but temporary measures but be set with checks and balances in nature.

Preventive measures : Acts, Rules, Regulations and Declarations for protection and preservation of heritage and environment and long term policy-planning are preventive in nature. However, such measures though difficult, need to be strictly practiced for effective result in the long run. To anybody's experience, it has not been found possible with "Ecopolitics" entering into ecology such that a "development" becomes a "degradation" or vice versa to persons or group of persons (political Parties) in the helm of affairs.

Adoptive measures and Symbiotic living : Nothing is more rational than to orchestrate our activities with natural principles as most National Environmental Policies direct. The choice to follow natural ecological principles protects our life support system and leads to more productive economic systems in th longer range. Designing, planning and implementing in concert with ecological principles can result in more satisfying integrated growth, environments and economics for all Willard, 1985).

An harmonic natural life style does not mean renouncement of a materialistic world and technological achievements and "going back to forests". It really means to have the materialistic needs but within a limit of the bearing capacity of the environment. The greatness or intelligence of man is in growing forest around him instead of going back into the forest It is possible to have television without promotion of consumerism which has been emphasised earlier as the basic cause for pollution and degradation. It is possible to survive with recycled and restricted consumption of non replenishable resources and use of energy by tapping of non polluting sources as some highly organised communities have been doing. Lastly, it is possible and desirable to have simpler and contended life-style without "Five Star" ostentatious living (at whose cost?) and not pretend that what was luxuries of fore father are essentials of today. As the most developed species and leader of the worldly family we must know how to lead and steer this space craft without fear and fight. Although the destiny of man is already made up in the evolutionary clock, let us walk

majestically into the end point instead of rushing in a Fast Local to the Evolutionary Terminus.

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21

A CRITICAL APPRAISAL ON ENVIRONMENT LEGISLATION

Dr. Anil Shukla

Tha hua and cry about pollution, tha issue of deterioration of the environment and the exhaustion of the planet resources was raisad by the highly industnalized countries in the third quarter of this century. Initially, no one listen to them, apart from a small group of spacialists, bacause man desirad for more joy and comfort has led him to exploit nature's frea goods to tha extent of reducing its natural capacitiaa for self stabilization. Since, long time, man has been indiscriminately manipulating the environment and natura to fulfil his harrow aelfish Interests. In tha process, he has sometimes left tha environment so badly mauled and mutilated that it is proving harmful to the humanity itself. Keeping in mind above facts, the United Nations organised the first Conference on the human environment at stockholm In 1972. It proclaimed that the protection and improvement of the environment for present and future generations is a pressing need of mankind. From that conference this area has become an issue of great concern all over the world. In India also, necessary steps have been taken in this direction for better environment, but adequate preventive legislation is quite essential to check the pollution.

Any how, initially the constitution of India has no direct effective provision for protection of environment, but taking note of Stockholm Conference and growing awareness of the environment, amended it to add direct provisions for protection of environment. If we make a careful analysis of Indian acts, then we find that many acts were introduced for the protection of environment, even before independence. These acts may be listed as below:

1. The Indian Fisheries Act, 1897.
2. The Indian Ports Act, 1901

3. The Bengal Smoke Nuisance Act 1905
4. The Explosives Act, 1908
5. The Indian Ports Act 1908
6. The Poison Act 1919
7. Andhra Pradesh Agricultural, Pest and Diseases Act, 1919
8. The Indian Boilers Act 1933
9. The Workmens Compensation Act 1927
10. The Motor Vehicle Act 1938
11. The Mines and Minerals Act, 1947
12. The Factory Act (Pollution and Pesticides) 1948
13. The Industries (Development and Regulation) Act, 1951
14. The Prevention of Food Adulteration Act, 1954
15. The Acquisition of Land for Flood Control end Prevention of Erosion Act, 1955
18. The River Boards Act, 1956
17. The Atomic Energy Act 1962
18. The Major Port Trusts Act, 1963
19. The Bidi and Cigar Workers Act, 1966
20. The Insecticides Act, 1968
21. The Cattle Trespass Act, 1971
22. The Wild Life (Protection) Act, 1972.
23. The Water (Prevention and Control of Pollution) Act 1977
24. The Urban Land Act (Ceiling and Regulation), 1976
25. The Water (Prevention and Control of Pollution) Act 1977
26. The Water (Prevention and Control of Pollution) Amendment Act 1978.
27. The Coast Guard Act 1978
28. The Forest Conservation Act 1980
29. The Air (Prevention and Control of Pollution) Act 1981
30 The Fairways Act 1981

31. The Environment (Protection) Act 1986, etc.

In addition to these acts, there are some more provisions for protection of the environment in tha laws of torts under negligence and nuisance under I.P.C. Section 268, 269, 272, 277, 278, 284-290, 298, 425 and 426 under C.P.C. Section 133 end 134 and under various municipal ects.

It would be worth while to mention here the acts, which are affected in Rajasthan State for environmental protection:

1. The Rajasthan Prevention of Certain enimals Act, 1950.
2. The Rajasthan wild animals and birds Protection Act, 1951.
3. The Rajasthan Forest Act, 1953.
4. The Rajasthan Municipal Act 1959.
5. The Rajasthan Soil and Water Act
6. The Rajasthan Noise Act, 1963.
7. Tha Rajasthan Produce (Establishment and Regulation of Saw Mills) Rules, 1983.
8. Besides, these major acts, all the policias of Govt. of India are also enforced in the state.

It is very interesting to know that India is one of very few countries in the world, which has provided for constitutional safeguards for the protection of environment. For instance erticle 48 A provides - "Protection and Improvement of Environment and Safeguarding of Forests and Wildlife. The state shall endeavour to protect and improve the environment and to safeguard the forests and wildlife of the country".

Article 51 also reveals that "It shall be the duty of every citizen of India (?) to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creature.

Article 47, 48, 49 and 51 and some other also provide legislative safeguard to the environment. But, anyhow, the efficacy of these articles is questionable. For the Indian environmental policies, Tiwari Committee (1980) noted some major short comings which can be summarized as follows:

1. Many of these laws are outdated.

2. They lack statements of explicit policy objectives.
3. They are mutually inconsistent.
4. They lack adequate provisions for helping the implementing machinery.
5. There is no effective procedure for reviewing the efficacy of the laws.

Some other shortcomings of these acts may be mentioned as follows:

1. Many of environmental acts have emanated from different agencies with different philosophies, technological cultures and perceptions.
2. Generally it was found that these acts come into the action after damage has been caused.
3. Factory acts of not to provide proper safety for outside. We must pay attention for the disaster of the factories.
4. Industrial safety today is a highly technical area of work, but the administrative part related to this area lies with the civil officers, therefore, this aspect has to be looked into by technical persons
5. Integration among different environmental rules is also essential
6. None of the Acts, state social objectives to be achieved resulting in their dilution during implementation and thus making them obsolete.

In fact, there is a need to look into existing environment legislation very thoroughly and some changes or amendment are also essential because these legislations are contradictory or not fully competent to protect the environment. For example, "The Water Act is responsible to take care of sea water only upto 5 kms. After this limit coast guards are responsible to taking such measures, which are necessary to control the marine pollution". This example indicates that co-ordination between these two agencies which is essential to check the marine pollution, but on legislative aspects, we are lacking.

In India there are sufficient legislative supports for the protection of environment. The new environment Act, 1986 is a milestone for the protection of environment, but this act appears to be rewritten version with some addition and deletions of previous legislation (Water act 1974, Air act 1981 etc.) but no doubt that this act is superior in its

approach as compared to earlier ones. Earlier acts were merely regulatory in nature but 1986 act favours "For the protection and improvement of environment and for matters connected therewith". This act empowers the Union Government to take necessary measures to protect and improve environment. Since this act has been introduced with lot of ambitions, so a critical appraisal of this legislation would be worthwhile here.

MERITS :

Environment act, 1986 provides legislative support for the safety of inside as well as outside of the factory:

1. This act gives a new direction to check the pollution of hazardous industries (Section 2E) (Section 8).
2. In this Act word "Pollution" has a very widersense and it is not limited to air and water pollution only (Ex-Section 6 (2) B.
3. Now with the help of this Act, private citizens are authorised to file a complaint in the court against a polluting unit or polluters in his individual capacity. Earlier this right was restricted to pollution control boards only.
4. India is the first country in the world, where provision has been made to make the head of a Government debt. Criminally liable if he failed to implement the rules of protection of environment section 17. Section 3 of the act provides for creation of an authority to issue directives and to co-ordinate the execution of some 35 major environment acts, that are currently in force.
5. From this act, the range of penalties has been increased for defaulters. For instance, now courts may order for the punishment of five years imprisonment or fine of Rs. one lakh or both.

This act provides a special provision to fix the liability for the offence committed by the companies and government debts. Section 16 empowersthat the person who is directly incharge shall be deemed to be guilty of along with other officers, if it is proved that the offence has been committed with the consent of such person.

DEMERITS

1. The main drawback of this Act is excessive centralization of the power in the hand of Central Government. There is no free delegation of power to the Sate Government (Sect. 3(2) V).

2. Another major drawback of this act is ineffectiveness of this act if an offence is punishable under this act and also under other act Section 24(2) speaks as follows: "Where any act or commission constitutes an offence punishable under this act and also under any other act, then the offender found guilty of such offence shall be liable to be punished under the other act and not under this act". This is an anomaly because most of of the fences committed under the new act, would also be punishable under the old earlier water and air acts, where penalties are less stringent.
3. In India, if any person wants to set up an industrial unit, then there is need of simple 'No Objection Certificate' from pollution control board. Actually, there is a pressing need to ask from Industrialist to submit an 'Environment Impact Assessment' report before the location chosen is approved, but this act does not provide such regulation.
4. Pollution of nuclear power is a grave situation for mankind. But problems of nuclear plants have not been incorporated in this act.
5. In other countries, the import of many chemicals have been banned, but proper attention is not paid in this act to the import and marketing of chemicals. ,

It is observed that there are enough legislations for the protection of environment but unfortunately the authorities responsible for administering these legislations are different. If we make a careful analysis of Indian approach to environmental regulations, then it seems that there are many contradictions in Indian approach itself. In fact, Indian approach to environmental regulation is very similar to British model, but in practice it is closer to the American model. As a result if it inherits the strength, it also inherits weaknesses of both the models. Similar to the British model, there exists enough flexibility in Indian environmental laws to seek voluntary compliance from polluters. This voluntary compliance, as the British experience indicates, may reduce the implementation cost significantly and at the same time, it can produce results without creating an atmosphere of hostility. Nevertheless, voluntary compliance does not appear due to the existing business bureaucracy relations. Despite flexible laws, the style of regulation implementation in India is similar to the American model, which is based on strict adherence to universal standards but once again, unfavourable local policy culture makes its impossible for local regulators to seek adherence. As a result, while hostility results, no enforcement has yet been achieved.

Since major drawback of Indian pollution control policy is its consistency with the local policy culture, the solution to the problem of enforcement this gap must also lie with the changing of policy culture. Efforts must be made to reduce the cost of complaints for pollulers and the cost of enforcement for regulators. Tragedies, such as the union carbide gas leak, may tilt the balance of cost benefit analysis in the favour of environmentalists. But the nation cannot wait for such catastrophies, nor can it afford further destruction of its physical environment.

Although there are many shortcomings in the Indian environmental policies and the removal of these shortcomings is not an easy task, yet a few strategies are being recommended here, which seem very worth while to protect the environment and for the effectiva implementation of present acts related to environment.

STRATEGIES:

1. Many of Environmental laws are out dated. They must be updatad with present naeds.
2. There are many inconsistencies among various acts. These Inconsistencias must be removed
3. There is not a very effective system to check the efficacy of thesa laws.
4. *Proper administrative support for these provisions* is also necessary, Therefore, adequate provisions for the implementing machinery is also required.
5. At the time ot decision-making the environment should be considered natural, social cultural resource etc..
6. Environmental policies should be reframed according to regional needs.
7. A sound administrative set-up for environmental management at local, regional and state level is necessary to chalk out the *ecodevelopmental programmes and to implement them through* suitable legislative measures.
8. Single Environmental Code or a comprehensive law of environment is also e pressing need of this country to meet out the problems of environment.
9. For the effective implementation of these provisions, Environmental courts should be established

10. Imposition of fines should be stopped, because generally polluters are rich man, so imprisonment is the only solution to restrict the activities of environmental victims.
11. Lack of knowledge, public apathy, intellectual indifference and the regulating agencies are the other bundles of effective Implementation of environmental laws.
12. The polluters should also be enlightened on the social obligations of the business.
13. Public awareness should have a scientific temper devoid of emotional surcharge.
14. One thing which is very important for the protection of environment is - "A political will, based on scientific wisdom".

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22

ACCEPTABILITY OF ENVIRONMENTAL LAWS - AN INDIAN EXPERIENCE

Dr. Satish Shastri

"The definition of common norms of behaviour is not in itself sufficient for tha creation of a body of rules and regulations.

To operata affectively, certain basic conditions must be fulfilled : the axistence of a general will among members of the community to accept and adhere to regulation; the existence of a political framework not only for defining and quantifying common behaviour or norms, but also for adopting existing rules to change within the community : a means of determining compliance with international rules and regulations; and finally, the means for enforcement."

The Stockholm Conferenca (1972) was a powerful force in arousing public awareness and understanding of the fragility of the human environment. The principles of the Stockholm Declaration (1972) are known as Magna-Carta on human environment as they provide a basic code of environmental conduct. It emphasized the urgent need of intensifying the efforts at the global, regional and national levels to protect and improve environment. The Declaration was reaffirmed and re-emphasized in Nairobi Declaration (May 10-18, 1982). It urged all the governments and people of the world "to discharge their historical responsibility collectively and individually, to ensure that our small planet is passed over to future generation in a condition which guarantees a life in human dignity for all."

The World Commission on Environment And Development in its report "Our Common Future" (1987) has suggested various ways and means for environmental protection and sustainable development. The Commission observed that 'national and international law has traditionally lagged behind events. Today, legal regimes are being rapidly outdistanced by the accelerating pace and expanding the scale

cf impacts on the environmental basa of development. Human laws must be reformulated to keep activities in harmony with the unchanging and universal laws of nature."[2] Annexure 1 of the report has enlisted twenty proposed legal principles for environmental protection to be adopted by the world governments. This whole goes to prove that law plays and has to play a very significant role in protecting and improving the environment.

India, one of the participants of the Stockholm Conference also voiced its concern about degrading and deteriorating environment. The Indian Parliament has passed many environmental laws to fall in line with the international efforts to deal with the problem of environmental pollution and eco-imbalances. Two articles-Articles 48-A and 551-A(g) were incorporated in the constitution by 42nd amendment in the year 1976. Article 48-A provides a constitutional mandate/pointer to the state 'to endeavour to protect and improve the environment and to safeguard the forests and wild-life of the country. 'Thus, it is a pious duty of the State to protect the environment from all activities whatever hazardous to public health. It is now a constitutional obligation of the State (The term 'State' includes all organs of the State including judiciary). It has been declared by the supreme Court of India that if this constitutional obligation is not abided by "the Courts will be left with no alternative but to intervene effectively by issuing appropriate writs, orders and directives..."[3]

A fundamental duty has also been imposed by the Constitution on the citizens of India under Article 51-A(g) which provides as follows :

Article 51-A : 'All the citizens of India shall have a duty- (g) to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures.'

The Indian Constitution is one of those few constitutions of the world which has provided a constitutional duty of the citizens to protect and improve the environment. In the words of Justice Ranganath Mishra, presently Chief Justice of India, "preservation of the environment and keeping the ecological balance unaffected is a task which not only Government but also every citizen must undertake. It is a social obligation ...."[4]

Besides these constitutional provisions, various Central and State laws have been passed relating to myriad aspects/ components of the environment. Some of the important Central Laws relating to environment are as follows :

1. The Environment (Protection) Act, 1986.
2. Water Pollution
   (i) The River Board Act, 1948
   (ii) The Merchant Shipping Act, 1970.
   (iii) The Water (Preservation and Control of Pollution Act, 1974).
   (iv) The Water (Prevention and Control of Pollution) Cess Act, 1977.
   (v) The Territorial Waters, Continental Shelf, Exclusive Economic Zone and other Marine Zone Act, 1976
3. Air Pollution
   (i) The Indian Boilers Act, 1923.
   (ii)) The Mines and Minerals (Regulation and Development) Act, 1947.
   (iii) The Factories Act, 1948.
   (iv) The Industries (Development & Regulation) Act, 1951.
   (v) The Air (Prevention & Control of Pollution) Act, 1981.
4. Wildlife end Forestry
   (i) The Wildlife (Protection) Act, 1972.
   (ii)) The Cruelty Against Animal Act
   (iii) The Indian Forest Act, 1927.
   (iv) The Forest (Conservation) Act, 1980.
   (v) The Indian Fisheries Act, 1987.
5. Radiation
   (i) The Atomic Energy Act, 1962.
   (ii) The Radiation Protection Rules, 1971.
6. Pesticides
   (i) The Poison Act, 1919.
   (ii) The Insecticide Act, 1968
   (iii) The Drug and Cosmetic Control Act, 1951.
   (iv) The Seeds Act, 1965.

7. Protection of National Monuments
   (i) The Ancient Monuments and Archaeological Sites and Remains Act, 1958.
   (ii) The Ancient Monuments Preservation Act, 1974.
   (iii) Antiquities and Art Treasure Act, 1972.
8. Others -
   (i) The Prevention of Food & Adulteration Act, 1954.
   (ii) The Urban land (Ceiling and Regulation) Act, 1976.
   (iii) The Hazardous Wastes (Management and Handling) Rules, 1989.
   (iv) The Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989.
   (v) Tha Public Liability Insurance Act, 1991.

A survey of the Indian Laws reveals that there are more than 250 enactments relating to environment passed either by the Central Government or by the State Governments. Yet, a plethora of environment laws has not been able to check the environmental degradation and eco-system imbalances. Here, we have to examine whether the environmental laws are acceptable to masses or not. In the discussion to follow, firstly we would examine acceptability of these laws; then the reasons as to why these laws are not popularly acceptable and, lastly, various practical suggestions have been proposed to implement these laws properly and effectively.

Acceptability of the Environmental Laws

The persistent degradation of the environment, rampant pollution and ecological imbalances raise certain fundamental questions -Does the environmental law communicate the desired message to the addressee? Is it fulfilling the needs of people ? Does it achieve the desired goals ? Do these laws fulfil the aspirations of the masses ? Is it able to meet the challenges faced by the society ? Are these laws acceptable to Indian people? These questions are important not just from the standpoint of law but they are quite crucial from the technocratic perspectives of natural resource management. A brief review of the environmental legislation was also done by the Tiwari Committee of 1980 which summarized the short-comings as follows :

1. Many of these laws are outdated;

2. They lack statements of explicit policy objectives;
3. They are mutually inconsistent;
4. They lack adequate provisions for helping the implementation of machinery;
5. There is no procedure for reviewing the efficacy of the laws.

The Tiwari Committee's conclusions are inferred by merely analysing the formal characteristics of the various laws but not relating to the actual socio-economic conditions of the implementation of laws. Therefore, the socio-economic viability of the laws should also be examined before we actually judge the failure or success of a particular law.

Social Conditions

India is a developing country comprising heterogeneous society. The population is increasing at an accelerating rate. In 1921, the population of India was 251 million, in 1981 it rose to 658 million and according to Population Reference Bureau, Washington, it rose to 800.3 million in April, 1987. This population explosion hes resulted into fast urbanisation (migration from villages to urban arees). Urbanisation has its own vices ·unauthorised and unplanned mushroom growth of colonies which lack basic needs and amenities like water supply, lighting, sewage, housing end transportation, etc. It ultimetely creates an unhygienic environment resulting in devastating effects. Unauthorised and unplanned clusters of colonies were most effected in the Bhopal gas leakage tragedy resulting in the death of more than 3000 persons. The laws are not able to cope with these gigantic problems. On the other hand, increasing population refuses to abide by the environmental laws which provides nothing but restrict their growth. Absence of public amenities compels persons to ease/defecate in the open, and urinate at the public places. The municipal laws which prohibit these activities in public cannot be 'and are not being implemented as countless persons would be punished daily for these wrongs. The state machinery is helpless to cope with the situation. Thus, laws are there, but are not acceptable to the majority of people in the society. Thus, such congregation of the persons results into unhealthful environment, insanitary condition, air and water pollution. land pollution, high mortality rate, lack of transportation, unemployment, human settlement problem, deforestation, etc.

The biggest problem related with the population explosion is poverty. In the words of Mrs. Indira Gandhi, poverty is the main cause of pollution. Thus, population, poverty and pollution. These three P are inter-related biggest problems, the world is facing. That is why it is said that poverty is the biggest polluter.

Table 1 : Basic Indicators of Poverty

Name of the country	Population (Millions) Mid. 1988	Area Square Km.	GNP Dollars 1988	Average annual rate 1965-88	Annual rate of inflation 1980-88	Life expectancy at birth 1988	Adult illiteracy Female 1985	Total 1985
India	815.8	3288	340	1.8	7.4	58	71	57
Mauritius	1.1	2	1800	2.9	7.8	67	23	17
Singapore	2.6	1	9070	7.2	1.2	74	21	14
USA	246.3	9373	19300	1.6	7.8	77	less than 5%	
UK	57.1	245	12810	1.8	5.7	75	less than 5%	

Source : World Development Report 1990, Poverty, p 178, Table 1.

The poverty line is that the level of income below which an individual or household cannot afford on a regular basis the necessities of life. In 1980, there were 340 million people in 87 developing countries, including India, not getting enough calories to prevent stunted growth and serious health risk. The number of people living in slums and shanty towns is rising, not falling. Such inequality affects the capacity of the society to improve the quality of life and on the other hand, increases pressure on the land. Thus, majority of population which is solely engaged to collect the necessities of life, seldom care for the environmental laws. Poverty is the main cause of the depletion of vegetation cover in India, which has in turn, invited natural calamities like flood, drought, erosion of soil etc.

Illiteracy

As per the report of the World Development Report, 1990 'Poverty' in India 57% of the total adults and 71% of the adult females are illiterate. Illiteracy has a direct bearing on environmental degradation. Reproductive behaviour of a society has direct connection with literacy in society. For example, the state of Kerala which has a distinction of having the highest literacy rate in India has the lowest birth rate.

Literacy helps one to understand the consequences of the acts of a man. It helps to understand the measures of population control and

the advantages of a small family. One can make the literate understand easily the advantages of the hygienic atmosphere as it is not easy to convince an illiterate to understand the advantages of hygienic atmosphere. Education helps us to overcome the problems of overcrowding, excessive population density, improve 'social carrying capacities, lowering down the birth rate, better nutrition and understanding the environmental problems. Literacy would also help people to understand laws and to abide by them.

Technical Reasons

Besides the general reasons as mentioned above, there are some technical reasons related with the environmental statutes, which are responsible for non-acceptability of the environmental laws. They are as follows :

1. A plethora of environmental laws makes it highly impossible to comprehend them. 'Too many cooks spoil the cury.'
2. The Tiwari Committee (1980) also observed that the majority of these environmental laws are not suited to the actual socio-economic conditions of the Indian society. A large number of these laws were either passed during the British regime or they are solely based on western laws. Thus, they are not best suited to the Indian society.
3. Law governing ecology and environment are complex. Indian illiterate masses cannot grasp them. It seems that these laws have been enacted for the environmental experts and not for common masses of India.
4. Environmental laws have not been propagated. A vast number of persons including majority of lawyers in India are unknown to these laws. This is because there was no public participation - national debate or public hearing - while these laws were legislated. There was no prior public notification of laws before they were introduced in the Parliament.
5. Procedure to prosecute the polluter provided by the environmental laws is complex, tedious, harassing, humiliating and time consuming. Sometimes, the prosecuting Boards often feel frustrated in being unable to bring the culprit to the book on account of technical legal problem. As in *U.P. Pollution Board v. M.S. Modi Distillery* the complaint against the water polluting unit of the Modi Distillery could not be entertained by the Chief Judicial

Magistrate for 5 years, till the Court was directed by the Supreme Court to proceed against the polluting industry. It could not be entertained by the CJM Court because there was some technical fault in the complaint and the industry was allowed to pollute the environment during this period.

6. Litigation process is extremely slow. There is a long gap between prosecution and pronouncement of the Court. Provision for appeal in these cases makes the process less effective. Many years pass before the polluter is punished as is evident from the Bhopal Gas case. The incident took place on December 2, 1984 and till today, the victims have not been adequately compensated. The case is still going on in the Supreme Court of India even after a lapse of six and a half years. Actual culprits have not ben prosecuted and punished.
7. Multiplicity of the authorities has further confounded the problem. Even an educated person is not able to understand whom to approach or complain in case one comes across a pollution disseminating activity or activity causing eco-imbalances.
8. A survey of the annual reports of the Pollution Boards makes it abundantly clear that there is a very low percentage of tha conviction in cases of environmental defaulters - only 6 out of 217 Industries were convicted till 1981 - barely 2.8 per cent success in the cases filed by the Central Pollution Board The data from State Boards presents a more dismal picture.
9. Section 17 of the Environment (Protection) Act, 1986 requires a 60 days notice by the person who wants to file a case against the polluter to the Central Government before filing a case. Such requisition unnecessarily delays the cases. Further, one is never sure whether the would get the approval of the Government. Therefore, people in general do not come forward to curb pollution activities.
10. Environmental laws fail to provide any incentive for the compliance since they operate on deterrent theory of punishment. According to Dr. Chhaterpati Singh, the retributive value of the penalties fails to deter because there is a total disparity between retribution and the economic benefits of non-compliance.
11. Inadequate number of personnel for implementation of environmental laws is one of the major drawbacks in getting these laws enforced. The pollution Boards have a meager number of persons

to prosecute and constantly pursuade the cases. The Rajasthan Pollution Control Board has a staff of 3 Legal Officers for the State which consists of 31 districts with a population of 34 million. Such a skelton staff cannot deliver desired results.

CONCLUSION AND SUGGESTIONS

The above discussion amply proves that the environmental laws are not effective and therefore, inefficacious and unacceptable to a large section of the society. It needs a rethinking, intelligent planning and restructuring of the laws.

Archiac and outdated laws should be repealed altogether. Because law should always respond to social change if ti is to fulfil its function as a paramount instrument of social order. The law should reflect the social change. It is rightly observed that law is the manifestation of the will of the people. Therefore, law ,and legal institutions should reflect tha will of the society end work accordingly Indian environmental laws should also speak of the will of the people. It should not be imposed by the legislative institutions, rather legislative institutions should legislate in accordance with the will of the masses. To make environmental law more effective, efficacious and more acceptable, the following are some of the suggestions :

1. There must be public participation in the law making process. Before a law is enacted, a public notice must be given to invite the public opinion and comments regarding the proposed law. Public hearings may also be held to involve the people in the law making process. Such public participation would make law a living law and reflect the will of the people. The Environment Impact Assessment (EIA) of every development plan must be made public. Public opinion must be gathered through public hearing or inviting public comments before a plan is permitted to operate.
2. A national committee may be constituted to review the present day laws. The committee should review and revise the available environmental laws to (a) cope with the present day problems; (b) coordinate the different pieces of legislation; and (c) remove the multiplicity of the authorities. This would enable the common man to understand the law.
3. The tedious, cumbersome, time consuming technical legal procedure should be done away with. Simplicity and quick relief are the virtues of a good law. It would attract the masses.

4. The law should provide that environment pollution and eco-imbalances cases be decided as early as possible - say within 3 months from the date of the institution of such case. This has been reiterated by the Supreme Court of India time end again.

5. To avoid unnecessary delay which allows pollution disseminating activity to continue unreasonably, Environmental Courts must be established without further delay. It would also help in taking action against the polluter immediately.

6. Having regard to the fundamental duty of the citizens of India provided under Article 51-A, the Central Government should introduce environmental courses at all levels of education-relating to the protection end improvement of the natural environment including forests, lakes, rivers and wildlife, Children should be taught about the need for maintaining cleanliness of the house both inside end outside. Clean surroundings leed to healthy body and healthy mind.

Looking to the poor turn out of the masses to formal educational institutions, masses should be given such education informally. Such as through adult education Programmes through mass media.

To contain population explosion, adults should be given sex education and taught various measures of population control to make the development plans successful.

7. The Supreme Court of India has suggested that 'In order to arouse amongst the people the consciousness of cleanliness of environment, the Government of India and the States may consider desirability of organising 'Keep the City Clean Week' once a year. During the week, village, town or city should be kept as far as possible clear, tidy and free from pollution of land, water and air. During the Week, all the citizens - including the members of the executive members of Parliament and the State Legislature members of judiciary may be requested to cooperate with local authorities and to take part in the celebrations by rendering free personal services.'

8. The Constitution of the Pollution Board must be changed and more public representatives be included in it. It would imbibe a confidence in the public to abide by the laws. Further, increasing public participation means increasing acceptability of the environmental laws.

9 The whole structure of the environmental law reveals that these laws are based on the *'Policing the Society Theory'* which assumes that law should work as a Policeman to detect crime and bring the offender to the Court. Thus, it puts the Board against the industry and producers against the environmentalists as enemies - opposed to each other. Our laws should be based on the 'Cooperative Model Society' - which tries to find alternatives through which various agencies of society can co-operate with each other in the task of improving and protecting the environment.

10. Some incentives should be provided for the compliance of environmental laws. For example, the Noise Control Act of USA provides that the Government Departments would purchase a product on priority basis which is less noise producing even if they have to pay 125 per cent more for that product.

To conclude, in the words of Justice Krishna Iyer :

"*I advocate a fresh comprehensive Environment Protection Code* up-dating, unifying the authorities, simplifying lexically, legally and structurally. The several Acts in force classifying the topics in separate chapters, prescribing for environmental boards, Environmental Courts, Environmental Ombudsman providing for public Interest-Litigation, affirmative action, wider rules of access to justice, combining in one action, civil and criminal remedies and vesting the power to enforce orders."

Thus, law should not act as Governor but as a helper to mankind to put the things in right perspective. Man and law should work in the spirit of co-ordination and co-operation Law should work as an instrument of social order so "the spring may not be silent, the sun may not be shy to shine in smog, the woods may be lovely, green and dark, Gandhi may live a hundred years more and air, water and atmosphere may be pure and fresh, and full of health.

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LAW RELATING TO HAZARDOUS WASTE MANAGEMENT : AN INDIAN PERSPECTIVE

SATISH SHASTRI

Scientific and technological edvancements end mismanagement of netural resources, have given rise to numerous anvironmental problems Such as pollution of weter, soif end air, with consequent edverse effects on flore end fauna, human health and well-being. These problems are actually a grafts of repid, unprecedented end unplenned development programmes in the guise of industrielizetion. Industries though contribute to the development and progress of a netion but their wastes end toxic effluents discharged freely in the eir, water and on land are doing irreversible, irreparable damage to mankind. Similarly, unbridled exploitation of renewable end non-renewable natural resources without caring for the waste and scree has caused ecological imbalances and environmental pollution problems. This in turn has not only affected the quality of life but threatened the very existence of mankind. Due to mismanagement and damage to the natural environment we have lost thousands of species of animals, birds and plants and some more are under constant threat of extinction.

The Bhopal holocaust (1984) where more than 3000 persons died and about 2 lakh were affected by the leakage of Methyl Isocyanate (MIC) gas, Love Canal incident of USA (1978) where residents of area wero evacuated and US Government spent more than $ 30 million in clean up operation. The Seveso Incident at North Italy (1976) where contaminated debris contained in steel drums were disposed in-nocuously admits barrels of vinegar in Pickle factory and it played havoc later on. Methyl-mercury-poisoning in the Minamata Bay (Japan, 1956-80) caused by the industrial release of Methyle and Mercury compounds resulted into several deaths and several types of

diseases including pre-natal brain damage, nuclear accidents at the three mile Island nuclear power station of the USA in 1979 and at Chernobyl, in USSR are the representative sample of the worst kind of threat to the present generation and to the posterity. Studies of these incidents reveal various kinds of short-term and long-term effects on human being, flora and fauna. A complete list of the various kinds ailments and reversible and non-reversible effects are still to be realised Some have been identified and evaluated and some have not been. The evaluation is not easy. Research on the adverse effects of MIC are still on. Chemical pesticides, fungicides, rodenticides have also added fuel to the fire. The persistence and ubiquitous nature, couples with the tendency for them to concentrate in organism as they move up the food chain, increase their toxicity to fish, birds and wildlife and, in turn, to man.

The cost of waste management and removal of toxicity of the substances is huge. The damage cost of clean-up of oil spill in tha ocean waters hava been estimated at $ 1,000 per barrel[1]. The accident at the seveso chemical plant in Italy caused damage estimated at $ 150 million and the cost of rehabilitation of damaged three mile-Island nuclear power station (after 1979) have estimated at over $ 1.5 million and the compensation in the Bhopal holocaust awarded by the Supreme Court is $ 470 million.

Looking to the multitudinous and menacing adversa effects of the toxic wastes[2] number of measures have been adopted on national, regional and international level from time to time. The Stockholm Declaration (1972) on Human Environment also raised its volca concerning the rapid acceleration of Science and Technology. It was declared that :

'a point has been reached in history when we must shape our action throughout the world with a more prudent care for their environmental consequences. Through ignorance or indifference we can do massive and irreversible harm to the earthly environment on which our life and well being depend Conversely, through fuller knowledge and wiser action, we can achieve for ourselves and our posterity a better life in an environment more in keeping with human needs and hopes'.

Accordingly principle 6 of the Declaration that :

'the discharge of toxic substances....must be halted in order to ensure that serious irreversible damage is not inflicted upon

ecosystems. Further, principle 7 directs that the states shall take all steps to prevent pollution of the sea by substances that are liable to create hazards to human health, to harm living resources and marine life...'

The world Commission on Environment and Development in its report entitled as *Our Common Future* (1987), has narrated industrial wastes and toxic substances as of the major 'common challenges' world is facing today[3]. It has proposed various institutional and legal changes to be adopted at national and international level

Accordingly, many world governments have adopted myriad measures to contain the menacing threat of industrial wastes and toxic substances including administrative, regulatory and legal measures. The United States passed the Solid Waste Disposal Act in 1960, the Resource Conservation and Recovery Act in 1976 and the Super fund Act in 1980 to deal with the Solid Waste problem. To control and regulate the menace of toxic substances the federal government passed to toxic substance control Act in 1977, the Pesticide Control Act in 1972, the Nuclear Waste Policy Act in 1982 and the Ocean Dumping Act in 1972 and many other laws.

Similarly, the United Kingdoms passed a comprehensive Code-the Control of Pollution Act of 1974 which provides various regulatory and control measures relating to wastes disposal. It also provide various regulatory and prohibitive measures to control the hazardous effects of the pesticides. The Radioactive Substance Act of 1960, The Nuclear Installations Act of 1965 and the Radiological Protection Act of 1970 provides measures for the safe disposal of nuclear waste.

India - one of the participants of the Stockholm Conference on Human Environment, has taken various steps to regulate and manage the industrial wastes and toxic substances. There are various laws which directly or indirectly deal with hazardous wastes and toxic substances. One of those is the Indian Penal Code (IPC) of 1860. The Penal Code declares the acts and omissions affecting the public health, safety and conveyance as offence under various sections under Chapter XIV[4]. But this old enactment does not hit directly the problem and is not sufficiently equipped to deal with newer perspectives of hazardous waste. The meager punishment provided for the offenses further reveals the ineffectiveness of the code provisions.

The Environment (Protection) Act was passed by the Indian Parliament in 1986 to comprehensively deal with the environmental problems. Section 3 vests power in the Central Government to take all such measures as are necessary or expedient for the purpose of protecting and improving the quality of environment and preventing, controlling or abating environmental pollution. Section 6 empowered further expressly empowered the Central Government to make rules on various items including (a) the procedures and safeguards for the handling of hazardous substances, and (b) the prohibition and restriction of the handling of hazardous substances in different areas. Accordingly, Section 8 enjoins upon persons to comply with the procedure laid down and the safeguards prescribed under the rules in the handling of hazardous substances.

In the exercise of the powers conferred by Section 6, 8 and 25 of the Environment (Protection) Act, the Central Government pass two important rules to deal with the hazardous waste end toxic chemicals. These are :

1. The Hazardous Wastes (Management and Handling) Rules, 1989; and
2. The Manufacture, Storage and Import of Hazardous Chemical Rules 1989.

The Hazardous Wastes (Management and Handling) Rules, 1989

These rules aim at to deal with the problem of hazardous wastes comprehensively. But it does not apply to (a) Waste, Water and exhaust gases as covered under the provisions of the Water (Prevention and Control of Pollution) Act of 1981, (b) Waste arising out of the operation from ships five kilometre as covered under the Merchant Shipping Act of 1958, and (c) radioactive waste as is has been covered under the provisions of the Atomic Energy Act of 1962.

The term 'hazardous waste'[5] has not been defined by the Rules but rule 3(i) provides that hazardous wastes means categories of wastes specified in the schedule. Thus the schedule provides a list of eighteen categories of hazardous wastes and their regulatory quantities[6]. These rules cover total spectrum of hazardous waste i.e. from its generation packing, storage, transportation, treatment and ultimate disposal of the hazardous waste

Primary responsibility to deal with and manage the wastes lies with the 'occupier'[7], generating hazardous wastes. Rule 4, provides that the occupier 'shall take all practical steps to ensure that such wastes are properly handled and disposed of without any adverse effects which may result from such wastes'. Further the occupier shall be responsible for proper collection, reception, treatment, storage and disposal of the waste.

Control Mechanism

It has been provided that either the waste should be disposed of or be treated at an authorized sites Rules 5, 6, 8, 10 deals the procedure to treat the waste. Rule 5 provides the hazardous waste shall ba collected, treated, stored and disposed only at the *authorized sites* and by the *authorized persons*. A person who intends to operate a facility for collection, reception, storage, treatment, transport and disposal of the waste shall make an application in form 1 to the Stata Pollution Control Board for the grant of authorisation (permit) for any of the above activities. The State Pollution Board may grant or rafuse to issue tha authorisation. The Board shall issue a permit (authorisation) if it is satisfied that the applicant (may be operator of a facility or the occupier) possesses appropriate facility and technical capabilities and equipment to handle the hazardous waste safely. In the absence of these the authorisation may be refused after giving reasonabla opportunity of being heard to the applicant.

The authorisation issued normally shall be in force for a period of two years from the date of issue. It can be renewed after the expiry of the said period. Such authorisation may be cancelled or suspended by the Board where the authorized person failed to comply with any of the conditions of the authorisation after giving the authorized person an opportunity to show cause the reasons for suspension and cancellation shall be recorded by the State Pollution Control Board.

Thus 'proper authorisation' by the State Pollution Control Board is really the *control mechanism*. This authorisation letter or permit is issued to a man who is well versed in this technique and who possesses proper and adequate facilities, technical capabilities and equipment to handle hazardous waste safely. When the authorisation is renewed, the Board once again statistic these conditions and that he is doing the work satisfactorily. The power to suspend or cancel the authorisation at any time during the authorized time is another check on the authorized person to handle the hazardous wastes properly[8].

Another 'control mechanism' is the *package and labelling* of the hazardous wastage. Rule 7 provides that 'before hazardous waste is delivered at the hazardous waste site, the occupier or operator of a facility shall ensure that the hazardous waste is packaged in a manner suitable for storage and transport and the labelling and packaging shall be easily visible'. Such labelling and packaging should be able to with stand physical conditions and climatic factors. It is further provided that packaging, labelling and transport shall be in accordance with the provision of the Motor Vehicles Act 1988[9]. Different class of labels have been designated for different type of dangerous and hazardous waste which a carrier should display.

Rule 8 further puts another check that the *disposal site shall be identified by the state* or the authorized person and the *Environment Impact Study shall be made before identifying a disposal site.* The State or a person authorized by it shall compile and publish the inventory of sites of where the material has been disposed. Such inventory shall contain the location and description, information relating to the amount, nature and toxicity of hazardous wastes at the site.

In case an accident occurs at the facility or waste site or *during* transport of hazardous wastes, the occupier is under an obligation to report the State Pollution Board about the accident immediately furnishing complete *details including* the *steps* taken to prevent, contain and alleviate the effects of accidents.

Import of Hazardous Wastes

Import of hazardous waste has been completely prohibited by the rules. As an exception such waste may be permitted to be imported. Such waste for processing and reuse as raw material after procuring a proper permit from the State Pollution Control Board. In such cast the exporting country should also inform and seek permission from the Central Government - which may granted or refused by it.

Manufacture, Storage and Import or Hazardous Chemicals Rules, 1989

Hazardous chemicals have been dealt with separately under these Rules of 1989 Detailed rules with minute details have been provided by it Following are requirement which a chemical industry shall be required to fulfil before it starts working or in case of an

5. Information to the persons liable to be affected : One of the important features of the Rules is to impose a mandatory duty on the occupier of the industry to take appropriate steps to inform persons outside the site who are likely to be affected by a major accident (Rule 15). Such information shall include -

(a) the nature of the major accident hazard, and

(b) the safety measures and the DOS' and Dont's which should be adopted in the event of a major accident.

This would serve as a public notice of the likely danger they are going to face with the commencement of the industrial activity, to the local persons. It would also help in meeting the exigency situation in a proper manner.

6. Safety Data Sheet : There is also a provision that the occupier of an industry shall arrange to obtain or develop information in the for of *safety data sheet* of the acute toxic flammable and explosives (Rula 17). It should be in accordance with the provisions of Schedule 9 of the Rules. Accordingly, *Safety Data Sheet* shall include chemical Identity, physical and chemical data, fire and explosive hazard data, reactivity data, health hazard data, preventive measures, emergency and first aid measures and manufacture/suppliers date etc. In preparing it, the occupier shall ensure that the information is recorded accurataly and reflects scientific evidence used in making the hazard determination.

Penalty for contravention of the provisions of the Act or Rules :

Section 15 of the Environment (Protection) Act 1986 provides that whoever fails to comply with or contravenes any of the above mentions provisions or rules, shall, in respect of each failure or contravention be punished with imprisonment for a term which may extend to five years or fine upto one lakh rupees or with both. In case failure or contravention continues with additional fine upto five thousand rupees per day.

If the failure or contravention continues beyond a period of one year, the offended shall be punishable with imprisonment for a term which may extend to seven years.

The Water (Prevention and Control of Pollution) Act, 1974 :

The Water (Prevention and Control of Pollution) Act was passed for the prevention and control of water pollution and maintaining or

restoring of wholesomeness of water. 'This Act is also intended to ensure that the domestic and industrial effluents are not allowed to be discharged into water courses without adequate treatment'. For this purpose the Act prohibits the use of stream or well for disposal of poisonous, noxious or polluting matter (Section 24). The Industries have also been prohibited from letting discharge or trade effluent into stream or well or sewer or land without the previous consent of the State Pollution Control Board (Section 25). Contravention of these provisions is liable to be punished with imprisonment for a term which shall not be less than six years and with fine (Section 44). This punishment may further be enhanced. If the such an offence is committed by the Government Departments, the Head of the Department shall be deemed to be guilty of the offence and shall be liable to be proceeded against and punished accordingly. (Section 48).

The Water (Prevention and Control of Pollution) Cess Act, 1977 :

The Water Cess Act 1977 aims at firstly, to augment the resources for the smooth and efficient function of the Central and the State Pollution Control Boards from the industries mention in Schedule I of the Act[12]. And secondly, to give incentive in the form of rebate of 70% of the cess on account of installing any plant for the treetment of Sewege and trade effluents[13]. Such rebate could be claimed only for that period during which the trade effluent gets properly end satisfactory treated by the plant. Thus, the Water Cess Act helps to some extent, in eliminating or lessening the hazardous waste end toxicity of the substance.

The Factories Act 1948 :

The Factories (Amendment) Act 1987 was passed by the Indian Parliament 'to provide specifically for the safeguards to be adopted against use and handling of hazardous substances by the occupier of factories and laying down of emergency standards and measure'. It was necessary in the view of substantial modernisation and innovation in the industrial field and mushroom growth of chemical industries which deal with hazardous and toxic substances.

Section.12 provides that 'effective arrangements shall be made in every factory for the treatment of wastes and effluents due to the manufacturing process so far as to render them innocuous and for their disposal.

Chapter IV A entitled 'Provisions Relating to Hazardous Process' was incorporated in the Factories Act 1948 in 1987. It consists of eight section - from Section 41-A to 41-H. Section 41-A provide that these State Governments shall set up a Site Appraisal Committee for the initial location involving hazardous process or its expansion which would examine and recommend to the State Government for its establishment or expansion.

It has been made an obligatory duty of the occupier to disclose all information including health hazards and the measure to overcome such hazards in the manufacturing, transportation, storage and other processes to the workers, the Chief Inspector, the local authority and the general public in vicinity (Section 41-B). Such information shall include accurete information as to quantity, specification and other characteristics of wastes and the manner of their disposal It is also a duty of the occupier to draw up an 'on-site emergency plan' and detailed 'disaster control measures' and to make them known to the workers and to the nearby dwellers.

The maximum permissible limits of exposure of various chemicels and toxic substances has also been laid down in Schedule II which must be adhered to by the occupier (Schedule enclosed).

It is also significant to note that Section 41-G has made it obligatory for the occupier of a factory where hazardous substances are used or handled to set up a safety committee consisting of equal number of representatives of workers and management. Such committee shall keep a watch in maintaining proper safety and health and to review periodically the measures taken in that behalf.

Penalty under the Factories Act :

Strict punishment has been provided by the Act for contravening the provision of Chapter IV-A of the Act. Section 96-A prescribes that person who is found guilty of contravening the provision of Chapter IV-A as mentioned above, shall be punished with imprisonment which may extend to seven years and with fine which may extend to two lakh rupees and in case failure or contravention continues with additional fine which may extend to five thousand rupees for each day. If it continues beyond one year after the date of conviction, the offender shall be punishable with imprisonment for a term which may extend to ten years.

The Public Liability Insurance Act, 1991 :

The aims to provide immediate relief to the persons affected by accident occurring while handling any hazardous substance and for the matters connected there with or incidental there to. It came into force on January 22, 1990. It is a laudable step in the direction of providing relief to the victims of accidents which need it immediately and to those who lose their near and dear one as it so happened in the Bhopal Gas Disaster.

The Act exacts an obligation on all the industries dealing with hazardous substance to give specified relief where death or injury is caused to any person or property due to the wrongful act, neglegence or default of any person. The act applies to other than the workman. Therefore, every owner of the industry handling hazardous substances has to take one or more insurance policy The Government owned end controlled factories are exempted from this clause.

Under this Act, the victim has to made an application for a claim within a period of five yeers from the date of the occurrence of the accident to the collector. The collector, after making proper inquiry in the claim, will dispose of expediously of such claim - say within three months of the receipt of the application. According to Section 8, *the right to claim relief* under Section 3 of the Act, is 'in eddition to any other *right to claim compensation....* under any other law.....'.

The Act further authorises the officers (the collector or any other person euthorized by the central Government) to call for information (Section 9), entry and inspection (Section 10), search and seizure (Section 11) and power to give directions including prohibition or regulation of the handling any hazardous substance, stoppage of supply of electricity, water or any other service (Section 12).

The Act provides that if an owner of the industry fails to take an insurance policy or comply with the directions of the authonties, he shall be punished with imprisonment tor a term which shall not be less than one year and six months and may extend to six years, or with fine which shall not be less than one lakh rupees, or with both[14]. It also impose personal liability of the person to the actual in charge of or responsible of the conduct of business[15]. Similarly, in case of Government Departments, the Head of Department shall also be deemed guilty and shall be liable to be proceeded against and punished accordingly[16].

The schedule attached with Act provides the sum of relief which can be provided under Section 3 of the Act. For example Rs. 12,500/– is the maximum amount which can be paid for medical expenses, for permanent disability this sum will include rupees 12,500/- by way of medical expenses and on the basis of the type of disability, upto Rs. 25,000/-. It also provides upto Rs. 1000/- per month for the loss of wages upto a maximum of three months. For the loss of property upto Rs. 6000/- may be awarded.

Thus, the Public Liability Insurance Act of 1919 is a welcome venture which would help a lot in the proper management of the hazardous substances. It is suggested that this benevolent piece of legislation must be reviewed from time to time, looking to fast changing scenario in this field.

Hazardous Waste, Toxic Chemicals and Judicial Activism :

The Supreme Court of India has declared time and again that right to healthful environment, pollution free air, potable water is one of the fundamental rights. Though the Indian Constitution does not expressly mention it but it is implicit in the right to life and personal liberty guaranteed under Art. 21[17]. Right to life is much more than the right to animal existence but it also includes moderate human conditions to live in healthy surroundings, pollution free environment. Thus, discharge of hazardous waste and toxic chemicals and substances into river is a violation of the right to life

The Supreme Court of India has entertained the writ petitions under Art. 32, where health hazardous and pollution disseminating activity has been ascertained/reported. Similarly, writ petitions have also been entertained by various High Courts of the States under Art. 226. of the Constitution. In *M.C. Mehta* v. *Union of India*[18], The Supreme Court directed the Kanpur City Municipal Corporation and other concerned authorities to take appropriate steps to stop the trade effluents of tanneries industry into the holy river, the Ganga. Further, Municipal Corporation was asked to instal treatment plants to treat the sewage/sullage which were discharged by the 17 rivulets into the river. And that the textile waste, power plant waste should not be discharged into the river. In this case, Mr. Mehta, an advocate by profession, and an public spirited person filed a writ petition complaining the acute pollution of holy river the Ganga. The pollution was the result of untreated human and industrial discharges in the river throwing of garbage, malfunctioning of the city sewerage system, throwing of solid

waste, dead bodies, semi-burnt corps into river Ganga, which rendered the water of the Ganga near Kanpur City unfit for drinking, fishing and bathing purposes. It was pointed out by the Court that to keep the river Ganga clean is a statutory obligation on the Municipal Corporation of the Kanpur City.

Similarly, the court declared in *Chhetriya Pradushan Mukti Sangharsh Samiti* v. *State of U.P.*[19] that every citizen has a fundamental right to have the enjoyment of quality of life and living as contemplated by Article 21 of the constitution and violation will be punished adequately. Thus, the courts have assumed a role of guardian and protectors against health hazardous activities and pollution disseminating activities affecting directly or indirectly the flora and fauna, micro-romanism and property.

It has been observed by the Supreme Court that a *national policy* has to be evolved for the location of chemical and other hazardous industries in areas where population is scarce. Chief Justice Bhagwati while delivering judgement in *M.C. Mehta V. Union of India*,[20] observed that :

'It is also necessary to point out that when science and technology are increasingly employed in producing goods and services calculated to improve the quality of life. There is a element of hazard or risk inherent in the very use of science and technology and it is not possible to totally eliminate such hazard or risk to the community. We cannot possibly adopt a policy of not having any chemical or other hazardous industries merely because they pose hazard or risk to the community. If such a policy were adopted it would mean the end of all progress and development. We can only hope to reduce the element of hazard or risk to the community by taking all necessary steps for locating such industries in a manner which would pose least risk or danger t that community and maximizing safety requirements in such industry. There should preferably be a green belt of 1 to 5 Km. width around such hazardous industries'.

In that case a major leakage of oleum gas took place on December 4, 1985 in one of the Units of the Shri Ram Foods and Fertilizer Industries, Delhi. It affected a large number of persons of the nearby area and caused death of an advocate. The district magistrate of Delhi immediately ordered under section 133 of the Criminal Procedure Code for the closure of the factory. On December 7, 1985 public interest litigation was filed in the Supreme Court of India by MR. M.C. Mehta - an advocate. The court considered the matter as of

grave concern. The court while delivering its judgement gave very important directions to be observed by the industry, e.g. Porper and adequate training of the workers, public address system for giving timely warning and adequate instructions to the nearby dewellers, proper and regular inspection of the industry by the concern authorities at least once a week, display of a chart stating the effects of chlorine gas on human body and its immediate treatment etc. It was further pointed out that the occupier (in charge of the activity), the Chairman and the Managing Director would be personally responsible for such leakage and for the payment of compensation.

One of the significant suggestions of the court wast o set up an *Ecological Science Research Group* consisting of independent, professionally competent experts in different branches of Science and Technology, who would act as an information bank, for the court end setting up '*Environmental Courts* on the regional basis with one professional Judge end two experts drawn from the Ecological Science Research Group keeping in view the nature of the case end expertise required for its adjudication'.

A memorable judgement was delivered by the Supreme Court in *Union Cerbide Corporation V. Union of India*[21]. It was in sequel to the famous Bhopal Gas Disaster Case[22] recording a settlement between the Union of India end the Union Carbide Corporation (UCC). It was declared by Justice Ranganath Misra that the principle in *M.C. Mehte V. Union of India,*[23] that in *Toxic tort actions* the eward for damages should be proportional to the economic superiority of the offender cannot be pressed to assail the settlement reached in the Bhopal Disaster case. In cases of *Mass tort action,* like this, quantification of damages can be had without attaching much importance to individual injuries. It was further, declared by the Court that in event settlement fund is exhautes, the Union of India should make good the deficiency. Orders were issued to establish a fulfledged hospital equipped as specialist hospital for treatment and research of MIC gas related afflictions. Operation expenses of which were to be borne by UCC. The Court also directed the Union of India to obtain appropriate medical Group Insurance cover to take care of compensation for the children born or yet to be born to exposed mothers - the prospective victims. The premium was to be paid out by settlement fund.

CONCLUSION AND SUGGESTIONS

An indepth study of the above mentioned laws and regulations reveals that the problem of hazardous wastes and toxic chemical has not been comprehended fully and properly. We are still ignoring the impending danger which is almost ready to engulf the human race. Menacing gestures of the problem of hazardous waste and toxic chemicals are threatening the existence of mankind. Big continents have almost become the dumping grounds of hazardous wastes. Many European countries (England, Germany, Italy etc.) and South African countries are providing dumping and disposal site for money. Thus, inviting the endemic/endless problems. Hazardous wastes and toxic chemicals is a premonition of a terrible disaster. The World Health Organisation (WHO) has estimated that over 500,000 persons get poisoned by pesticides every year in the third world countries.

Mass disasters and multinational liability have further complicated and confounded the problem. The hazardous wastes of one country are transported to another country for disposel purposes. So it crosses the boundary of many countries. The transboundary transportetion problem multiplies the problem as carrying hazardous waste means carrying dangerous virus of epidemic diseases. It is high time we comprehended the problem and took necessary safe and edequate steps to contain or if possible to wipe-out the problem.

Third World Countries

Third World countries have proved to be good dumping grounds for various types of wastes. Some of the countries have accepted the wastes of other countries for consideration without visualising the dangers inherent in it. Therefore, the wastes management has to be given new thinking and direction.

Role of law in managing the hazardous wastes and toxic substances is very important. A study of the present day laws reveals that they have failed to achieve the desired objectives. It seems that (1) the laws have been made in haste without comprehending the problem fully; (2) they are not properly couched; (3) there is lack of will to implement them; (4) there is no proper machinery to implement them efficiently and effectively; and (5) piece meal legislation has further confounded the problem. Therefore, the following are some of the important suggestions to improve upon the present day situation and to implement the laws efficaciously, effectively and efficiently.

1. Laws relating to hazardous wastes and toxic substances must be consolidated, codified in a single *comprehensive code* embracing all spectrum of it. Piece-meal legislation always results into inefficiency, ineffectiveness of the law and multiplicity of the authorities.
2. To prepare unified comprehensive code it is suggested that a *national committee* should be established to review the whole spectrum of hazardous wastes and toxic substances and to introduce newer technology and newer approach to the problem. The lawyers, scientists and technocrats specialized in this should be the members of this National Committee.
3. The new code should also emphasize on resource recovery system and resource conservation aspect of the problem.
4. The definition of the term 'hazardous wastes' provided by the Hazardous Wastes (Management and Handling) Rules 1989 is superfluous. It provides that it means categories of wastes specified in the schedule. Without defining the term, the rules have provided a schedule which can be revised or re-revised in due course of time. It shows the state of uncertainty in the minds of the drafters of the Rules of that they were hesitant in defining it. Therefore, a proper and potent definition should be provided.
5. Domestic Sewage and Garbage have no-where been dealt with. There is no law which explicitly deals with them. Therefore, new unified law should also deal with domestic sewage and garbage - their collection, storage, treatment, disposal etc.
6. The Central Government or the State Government with the help of the Central Government should set-up Research laboratories so as to develop newer and cheaper methods to treat the hazardous wastes and toxic substances and provide the same to the industries on subsidised rates as an incentive.
7. Research reports about the toxicity of a substance and their effects on animate and inanimate objects of the waste should also be published in leading newspapers. So the general masses may also have the knowledge of the danger they are facing or likely to face of the wastes and toxic substances.
8. Import of highly toxic substance and wastes dangerous to human health and well-being should be altogether banned.

9. The use of Third World Countries and oceans as dumping grounds should completely be banned by appropriate international laws.

10. A proper notice should be given to the local persons of an area where an industry is intended to be installed. *Such public notice* should include the description of the industry, a list of toxic substances or hazardous wastes it is going to produce and likely dangerous and damaging capacity of these toxic substances and hazardous wastes.

    After giving a proper notice and reasonable time to comprehend the dangers they are going to face the persons of the area should also be asked whether the industry of the dumping site should be permitted to operate in their area. Only after procuring this *public consent* license/permit should be issued to an industry of the dumping site should be permitted to operate.

11. To establish Environmental Courts on regional basis is the cry of time. The court should have atleast one professional judge and two experts drawn from the Ecological Science Research Group (ESRG) keeping in view of the nature of the case and expertise required for its adjudication. Such ESRG should consists of independent, professionally competent experts in different branches of Science and Technology, who would also act an 'information bank'.

12. The cases relating to hazardous wastes and toxic substances should be decided by the courts as early as possible and death with on priority basis. Such cases should be decided say within two or three months. Early decision in the matter helps in curbing containing the pollution disseminating activity and in taking the appropriate and timely measures.

13. Requisition of 60 days notice to the Government to bring a suit under the Environment (Protection) Act should be done away with. The citizens should be permitted to bring an action against erring persons/institution/industry - public or private without undergoing this requisition. Waiting period of 60 days sometimes frustrates the purpose, helps erring industry to remove the evidence of culpability and results in harassment of the public spirited citizen. *Further, it is true* that *delay defeats justice.*

14. The Environment (Protection) Act 1986 has no provision for the compensation to the victims. Therefore, appropriate legislation should be passed making the industry or individual liable to pay

compensation to the victims immediately within a definite time. The liability to pay compensation should be based on the principle of strict liability.

15. 'Public Education Programmes' relating to the management and handling of hazardous wastes and toxic substances should compulsorily be given to all the students. General masses should be taught through adult education and mass media programmes.

16. Land use policies of the government should develop plans that would provide incentives to industries that have a high pollution potential to locate away from populated area and that would, in turn, discourage people from moving close to plants and waste disposal sites.

17. New laws and regulations should also have provision to involve local persons and voluntary non-Governmental organizations (NGOs) in major sating decisions and emergency preparedness planning.

Thus, an integrated comprehensive legal approach should aim at reducing the amount generated and transforming an increasing amount into resources for use and reuse. This would reduce the volume of wastes which must be treated, or disposed of through incineration land disposal or dumping at sea. Therefore, this titanic problem should be solved on 'cradle to grave approach'. It should be contained and controlled before it is proved environmentally disastrous for mankind.

HAZARDOUS WASTES (MANAGEMENT AND HANDLING) RULES, 1989

SCHEDULE

[see rules 3(i), 3 (n) and 4]

Categories of Hazardous Wastes

Waste Categories	Types of wastes	Regulatory Quantities
1	2	3
Waste Category No. 1	Cyanide Wastes	1 kilograms per year calculated as cyanide
Waste Category No 2	Metal Finishing Wastes	10 kilograms per year the sum of the specified substance calculated as pure metal.
Waste Category No 3	Waste containing water soluble chemical compounds of lead copper zinc, chromium, nickel, selenium, barium and antimony	10 kilograms per year the sum of the specified substance calculated as pure metal

2. According to Purdom and Anderson in *Environmental Science* (1983) p. 372, the hazardous waste may have the following characteristics (1) Ignitable, (2) Corrosive, (3) Reactive, (4) Toxic, (5) Radioactive, (6) Infectious, (7) Phytotoxic, (8) Teratogenic and mutagenic.

3. Chapter 8 of '*Our Common Future*' has dealt with the problem of hazardous waste and toxic substances. It has suggested several measures to be adopted by the national Governments and the International bodies.

4. Section 268 declares Public Nuisance, as punishable act. Similarly, various other sections provide punishment for various kinds of acts - such as Section 269 deals with negligent act likely to spread infection of disease dangerous to life, Section 277 Fouling Water of Public Spring or reservoir, Section 278 making atmosphere noxious to health, and Section 284 punished negligent conduct with respect to poisonous substances, etc.

5. Section 2(e) of the Environment Protection Act defines the term 'hazardous substances' as follows - 'hazardous substance means any substance or preparation which by reason of its chemical or physio-chemicals properties or handling is liable to cause harm to human beings, other living creatures, plants micro-romenism property or environment.

6. Schedule enclosed.

7. Section (2f) of the Environment (Protection) Act, 1986 define the term 'occupier in relation to any factory or premises, means a person who has control over the affairs of the factor or the premises and includes in relation to any substance, the person in possession of the substance.

8. Rule 8 empowers the Board to suspend or cancel the authorisation.

9. Rule 129 of the Motor Vehicles Rule of 1988 provides that the every goods carriage carrying hazardous and dangerous wastes shall display distinct mark of the class label shown in the Table of Rules.

10. Schedule 2 and Part I of Schedule 3 have provided the threshold quality of the chemicals Part I has divided these chemicals into 4 groups namely - 1. Toxic chemicals, 2. Toxic chemical group 2, 3. Highly Reactive chemicals, 4. Explosive chemicals. Part II of Schedule 2 provides the threshold quantity of- Flammable chemicals.

11. Schedule 5 has provided different authorities for different kind of activities e.g., for notification of hazardous chemicals concerned authority is the Ministry of Environment and Forest, for preparation of off-site emergency plans concerned authority is District Collector, for Import of hazardous chemicals it is the Chief Controller Imports and exports.

12. They are (1) Ferrous Metallurgical industry, (2) No-ferrous metallurgical industry, (3) Mining industry, (4) Ore processing industry, (5) Petroleum industry, (6) Petro-chemical industry, (7) Chemical industry, (8) ceramic industry, (9) cement industry, (10) textile industry, (11) paper industry, (12) Fertilizer industry, (13) Coal industry, (14) power generating industry, (15) processing of animal or vegetable product industry.

13. Section 12.

14. Section 14.

15. Section 16.

16. Section 17.

17. *Chhetriya Pradushan Mukti Sangarsh Samaiti v. State of U.P.* AIR 1990 SC 2060; *F.K. Hussain v. Union of India*, AIR 1990 Ker. 321; *T. Damodhar Rao v. S.O. Municipal Crop., Hyderabad*, AIR 1987 AP 171; *Kinkari Devi v. State of HP*, AIR 1988 HP 4.

18. AIR 1988 SC 1115.

19. AIR 1990 SC 2068.

20. AIR 1987 SC 965 at p. 980-981.

21. AIR 1992 SC 248.

22. Charan Lal Sahu V. Union of India, AIR 1990 SC 1480.

23. AIR 1987 SC 1086.

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ENVIRONMENTAL AUDIT : An Inevitable Strategy

S.K.AGARWAL AND N.J.SINGH

INTRODUCTION

India has been undergoing industrial revolution in a big way during the last one decade or so. With the recent liberalization of our industrial policy, industrialization will get a further boostup. Time is not far when India will be counted among the highly industrialized countries, even competing with the Western World. Consumer goods will be available freely. Exports will go up considerably. Foreign exchange will flow in gushes. Gross net productivity will be elevated. Economic conditions of the common man will improve. Prosperity will prevail. India will again become the legendary "golden sparrow" This is all proverbial " one side of the coin".

The other side of the coin is not so glittering. As is well known, industries induct solid, liquid and gases into our environment. Unless therefore, the wastes are effectively managed, our environment may get damaged beyond retrievable Already, some of our highly urbanized and industrialized areas are rolling under the impact of the induction of pollutants. Our natural resources like air, water (both surface and ground) and soil are being subjected to environmental stresses and deserve immediate attention

Responsibility is equal and heavy on the management of the industries, pollution regulatory authorities and the non-governmental organisations. We are all a part of one society, existing in the same environment. With the growth of industries, the environmental problems could assume serious dimensions (Arora and Arora, 1993).

GENESIS OF ENVIRONMENTAL AUDIT

Department of Environment, Ministry of Environment and Forests, Government of India has been making relentless efforts to ensure that the environmental pollution levels are contained to acceptable limits in

order to protect the environment. So as to achieve the noble objective DOE has enacted the Water (prevention and control of pollution) Act, 1981 and the Environment (Protection) Act, 1986 for religious implementation by the industry and monitoring by respective pollution control Boards. The DOE has been issuing modifications of the rules under these acts from time to time. Environmental audit is the latest modification issued under Extra Ordinary Gazette Notification dated March 13, 1992.

The rule reads, "Every person carrying on an industry, operation or process requiring consent under Section 25 of the Water (prevention and control of pollution) Act, 1974, or under Section 21 of the Air (prevention and control of pollution) Act, 1981 or both, the authorization under the Hazardous Waste (Management and handling) Rules 1989 issued under the Environment (protection) Act, 1986 (29 of 1986) shall submit an environmental audit report for the financial year ending the 31st March in Form V to the concerned State pollution Control Board on or before the 15th of May every year (extended to 30th September 1993 for the first audit)".

Before we touch upon the subject of Environmental Audit, it would be pertinent to introduce and briefly discuss two other environmental management issues (1) Regional carrying capacity, and (2) Environmental impact assessment.

REGIONAL CARRYING CAPACITY

According to the concept of regional carrying capacity the maximum population that can be supported indefinitely in a given habitat without permanently impairing the productivity of the ecosystem upon which that population subsists. The diversity of environmental factors limits the size of the population according to the available resources. The difference between the biotic potential and the carrying capacity is due to the environmental resistance (Agarwal, 1993). For human society, however, carrying capacity can be defined as the maximum rate of resource consumption and waste discharge that can be sustained indefinitely in a defined planning region without progressively impairing bio-productivity and ecological integrity. Studies on regional carrying capacity of late has assumed great significance as it gives an insight into the quantum of pollutants that can be afforded to be released into the environment mainly depends upon:

(a) Background quality of environmental components such as air, water and soil.

(b) Micromenteorological conditions.

(c) Climatic conditions.

(d) Human settlements.

(e) Land use patterns.

(f) Flora and fauna.

(g) Assessment of nature and quantity of pollutants inducted into the environment.

These are but a few major aspects to be considered while studying the regional carrying capacity (Figure 1).

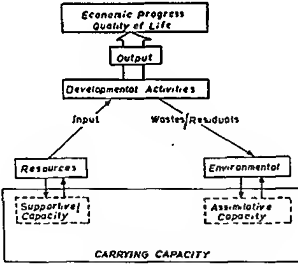

Fig. 1· Concept of Regional Carrying Capacity.

Fig 1

ENVIRONMENTAL IMPACT ASSESSMENT

EIA is intimately linked to the concept of carrying capacity. It is an ideal anticipatory mechanism which brings out the background quality of the environment before the commencement of a project and there after. Table 1 gives indicative and presumptive features of the areas around some projects. The damage caused by Bhopal accident would have been much less if congested human settlements had not existed in the host and proximate areas of the Union Carbide Pesticide industry. In Chambur and other parts of Bombay, in Ahmedabad-Baroda belt (and probably almost everywhere else in the country) human population, sensitive targets and the hazardous industries seem to be hugging each other. This has not only to be avoided in future but the past has to be rectified to the extent possible.

By recommending the shifting of the site of the proposed natural gas based fertilizer plant of Aravalli Fertilizers in District Sawaimadhopur (Rajasthan) from Bilopa to a site about 12 kilometre west, it seems possible to minimize the risk of contamination of ground/surface waters (due to different nature of the soil strata and different topography and drainage pattern) besides further reducing the already small risk to the Ranthambhor Sanctuary. Similarly, the proper choice of the location in case of the 1.0 MT Cement Unit of Zuan Agro at Mandalgarh in Rajasthan the risk of dust pollution at Mandalgarh town has been minimised.

A careful study of the likely impacts at different locations around a proposed project and proper siting and land use planning are the only fool proof ways of minimizing risk and adverse Impacts in future.

Thus, we see that EIA is a handy tool for calculating the nature and magnitude of impacts of a proposed project. The study facilitates examination of various alternatives in process technologies by the use of raw materials with relatively low pollutional potential. It also facilitates examination of cost effective and efficacious pollution control systems. The major components of an EIA are:

(a) Ecological aspects

(b) Pollutional aspects

(c) Socio-economic aspects

(d) Human interests.

EIA is a precursor to the study of Carrying Capacity and is of invaluable significance.

Table 1: Classification of some features of areas around projects (Agrawal, 1992).

Category	Indicative Geographical Limits		Nature and Magnitude of Risk Average Impact		
	Land Area	Stream Stretch	General	Air Quality Degradation	Water Quality Degradation
a. Host	Major Industry One km. all around the battery limits. Medium Industry Industrial Estate 0.5 km. all around periphery	1.0 km U/S of outfall to 5.0 km. D/S of outfall. In case of lake sea 1.0 km radius outfall	Noise, traffic, odours, dust, disruption of [illegible] grave immediate and all time risk from accidents as damage to life, health, flora, fauna, property etc.	Severe at many times e.g. Cement Plants SPM 800-1500 $kg\ m^{-3}$ Thermal Power Fertilizer Refineries NH_3 2-5 PPM SO_2 150-300 $kg\ m^{-3}$	Severe when dilution is low ecology affected fish kills may occur periodically
b. Proximity	Major Industry Downwind 3 km. Others 2 km Medium Industrial Estate Dominant Down Wind 2 kms. Other 1 km.	From 3 km. U/S up to 20 km D/S or where dilution available becomes 20 or more also 2 kms. U/S on all tributary streams joining in this reach	Risk and damage when transient accidental releases accompany adverse meteorological conditions lead injury to plants, health and life loss in humans, animals etc.	Severe at some times. SPM 500-800 SO_2 100-150 NH_3 1-2 PPM	As above DO may touch 2.0 or lower at times, ecology may get severely affected
c. Significantly affected	Major Industry Dominant down wind 5 kms. Others, 3 kms. Medium Ind. Estates Dominant DW 3 kms. Other 2kms.	Upto 40 kms. D/S or where dilution becomes 50 or more	Nuisance on few occasions effects on yield and growth of sensitive plants and health of sensitive humans and animals. Risk in case of very serious accidents.	Moderate occasionally SPM 300-500 SO_2 30-100 NH_3 0.1-0.5 PPM	DO recovers but ecology still may be severely affected.
d. Moderately affected	Major Ind. Dominant Downwind 8 Kms. Other 6 Kms. Downwind 5 Kms. Other 3 Kms.	Upto 60 kms. D/S or where dilution becomes 100 or more	Some nuisance occasions	some risk. Some subtle effects on flora and fauna of sensitive species and individuals.	Some at some SPM 200-300 SO_2 20-30 NH_3 0.05-0.1 PPM
e. slightly affected Unaffected	Beyond (d)	Beyond (d)	Imperceptible	SPM & SO_2 10-20	Almost normal

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EIA is a precursor to the study of Carrying Capacity and is of invaluable significance.

ENVIRONMENTAL AUDIT

Indian industry has been voicing various misgiving on several counts regarding environmental audit. Our industry was opposed to such public disclosure and was trying its best to block the amendment, by arguing that, "we do not believe that the Indian public was mature enough to understand the implications of such data It could lead to unnecessary litigations and harassment for companies in the guise of public interest litigations"/ However, this is contrary to the situations in Europe where some companies publish environment audit in their own to placate an increasingly environment - conscious public. Countries such as United kingdom and the Natherlands have encouraged their industries to conduct environment audits since the mid 1980's, but it is not mendatory

Expressing worries about the confidentiality of corporete secretas, the indian industry is unwilling to publish datails of raw materials used because it could reveal secret concerning materials and processes It has baen suggestad thet the government, for the timebeing, should restrict eccess to audit data to the State pollution control boards concerned and to an expert egency that could analyses the data

Our industry was also apprehensive that the environmental audit data it supplies could be used by pollution Control Boards for persecution at soma future date. However, Information about a Company's effluent are already being submitted to the State pollution Control Boards concerned. If the prescribed limits are exceeded, the Board can prosecute the Company. So the submission of the Audit reports will not provide the Board with additional opportunity to prosecute the Company.

Another hitch that will be encountered is the belief of lack of technically qualified environmental auditors. MEF envisages solving this problem by setting up of a Committee of experts. Furthermore, Companies below a size that is yet to be decided may be allowed to conduct in-house audits. But larger Companies will have to have approved environmental auditors (Jacob, 1993).

Industrial concerns and local bodies should feel that they have a responsibility for abatement of pollution. An environmental audit

evaluates the effect of the policies, operations and activities on the environment, particularly compliance with the standards and the generation of and recycling of wastes. An annual audit report will help in identifying and focussing attention on areas of concern, practices that need to be changed and plans to deal with adverse effects under environmental audits The measures will provide better information to the public. The Confederation of Indian Industries is trying to educate industries and make them recognise that despite its mandatory nature, the environment audits need not be seen as yet another sword Instead they can be viewed as a strategic tool to improve manufacturing efficiency, reduce risks and hazards and waste right at the source In fact, if audits are directed towards minimising wastes. It will not only conserve resources and reduce expenditure on pollution control measures but also improve profitability and competitiveness The new *economic policy, therefore is likely to motivate industries to undertake* environment audits with this perspective (Niyati, 1993)

Environmental audit could be termed as "post-mortem" of pollution potential of an industry. Thus, regional carrying capacity and environment impact assessment precede the very installation of an industry, environmental audit succeeds the projects for verification of basically pollution control facilities and their efficacious It is essentially a management tool comprising a systematic, documented, periodic and objective evaluation of how well environmental organisation, management, systems and equipment are performing.

The aims of environmental audit are

- Waste prevention and reduction.
- Assessing compliance with regulatory requirements.
- Facilitating control of environmental practices by the industry's management, and
- Placing environmental information in the public domain.

The objectives of environmental audit have been clearly defined so as to avoid varying interpretations, which could result and contribute to differences in approach thereby influencing the end result. These objectives are:

- *To facilitate effective* management of pollution control practices
- To ensure that appropriate pollution control measures are installed have a proper placement.

- To ensure that adequate pollution control is achieved to meet regulatory standards.
- To conserve resource like water, petroleum products etc. by recycling
- To ensure by-product/ final product recovery to offset the cost of pollution control facilities.
- To promote environmental awareness among industrial workers and local community.
- To ensure good relations with community by containing pollution
- To make recommendations for achieving aforementioned objectives, if so required

In the industries, especially of the chemical Industries, raw materials are used in excess of the stoichiometric requirements because of the limitations on practically achievable operational efficiencies and the raw materials purity. This excess usage of raw material, unless recovered, find their way to the environment causing pollution End of the pipe treatment techniques, wherein all the wastes are carried to a common facility and treatment provided, is ineffective and uneconomical due to the complexity of the problems associated with waste generation, their quality and characteristics. The waste generation may vary hourly, daily and seasonally. In this growing complexity of problems, the concept of waste prevention at reduction can work out to be more effective.

It is also Imperative that the management of a industry should have a clear picture of attitudes of technical capabilities of the organisational set-up for protecting the environment pollution control status and their bounden social obligation related to environment so as to decide on the future mode of actions. It is equally important to make public aware of the environment information of the industry so as to build in among them confidence in the industry in which they are share holders or residents in the neighborhood. Environmental audit has far reaching benefits to the industry, to the society and the nation at large. It Identifies process operations for improvement of performance and reduction of losses, identifies potential cost savings by waste minimisation/recycle/recovery, provides upto date environmental data-base, ensures independent verification and helps in solving / reducing regulatory risk and avoiding the wrath of public litigation.

inspection by a regulatory agency (most inspections are scheduled) the industries are notified of an audit. With sufficient planning, a successful audit can be accomplished with a minimum of disruption. The important planning steps include:

(1) Collection of preliminary information of the industry through a questionnaire survey and identification of main areas of concerns;

(2) Mobilizing resources such as the sampling and monitoring equipment and laboratory facilities for analysis;

(3) Constitution of an audit team and allocation of specific tasks to team members; and

(4) Development of visit schedule for information to the industry in advance.

ACTIVITIES AT THE SITE

Environmental audit should not be treated under any circumstances as a raid. The management and the employees should be prior informed about the purpose of the audit. Except in the case of a surprise inspection, all concerned authorities should be well prepared. Almost anything that happens in a process industry can be audited (Singh, 1993). Some of the major activities at the site during environmental audit include the following activities.

- Identification of process unit operation, working out inputs of energy, raw materials, water etc., and out-puts of products, byproducts and waste (liquid, gaseous and solid) generation and deriving material balance and water balance.
- Identification of waste flow routes, and obtain details of pretreatment, final treatment and disposal of wastes.
- Designing monitoring network for sampling waste water, emissions, solid/hazardous waste to review the performance of pollution control systems and to review the impact on the ground water, air, stream and surrounding land uses, determining parameters for analysis and frequency of sampling and analysis of samples.
- Identify problems and investigating for possible solutions, and
- Preparation of a draft report on the visit with findings and recommendations and discussions with the management of the industry.

Post Audit Activities: These include data synthesis, final report preparation, drawing action plans with time-frame for implementation of recommendations for pollution control and follow-up on action taken The data synthesis includes the following:

(1) Evaluation of the problems related to waste generation, treatment and disposal.

(2) Identification of the problems related to waste generation, treatment and disposal.

(3) Identification of obvious waste segregation and waste reduction measures, and

(4) Formulation of recommendations for the best practicable waste management.

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ENVIRONMENTAL AWARENESS : AN IMPORTANT STRATEGY

R.M. Lodha

The world will be more crowded, more polluted, less stable ecologically and more vulnerable to disruption, if the present trends of environmental degredation continue. Serious deterioration of egricultural soils will occur world wide Atmospheric concentretions of carbon dioxide and ozone depleting chemicals are expected to increase to give birth to many serious diseeses. Extinctions of plant and enimal speciss will increase along with vanishing their habitats of all the problems, environmental problems are the hardest for human societies to solve because individuals seldom have to pey directly for their contribution to these problems. Individuals act in ways that promote their own short-term welfare, which often conflicts directly with the long term environmental interests of the present and future generations. According to 'The Global 2000 Report', the human conditions will be bleak by the beginning of the 21st century. Let us believe that novel and sophisticated technological solutions will be found to solve our problems of environment. A study of historyy provides examples of both successes and failures in meeting environmental problems In this Context, it should be remembered that we as an individual, contribute something and devote ourselves to environmental protection. Although much damage has already been done and the process of degeneration is continuing to some extent, fortunately for us an awareness has also grown everywhere about the eminent threat that looms large above us because of our reckless exploitation of the resources. A positive approach towards the understanding the environment and initiating action towards its improvement by elimination of faulty human inter-ference and preservation by planned development are being adopted by most of the countries.

In India too, the establishment of the department of environment in November, 1980 by the Central Government activities have been enhanced. This department is a controlling agency for all of the environmental issues in the country. One of the responsibilities of this department is creating the environmental awareness. As a matter of fact, it is a major responsibility and at the same time very tough too. However, once awareness against any negative aspect is there, nothing more is needed. By environmental awareness action may be initiated towards its improvement by eliminating faulty human interference and cultivating environmental perception This awareness can be cultivated by establishing the clubs, regulating laws, imparting education establishing schools of Environmental sciences. etc.

Awareness Through Clubs:

The DDE has started Environmental Clubs at School level by extending financial assistance worth Rs. 1000//- per year. Through such Clubs the students are expected to study the environmental conditions in their surroundings. The another very important step has been taken by DDE by establishing the 'PARYAVAN VAHINI' or clubs at each district Headquarter under the Chairmanship of the District Collector. In this 'Vahini' the number of the members will be around 100, consisting of administrators, students, academicians, members of voluntary organisations, social workers, eminent citizens, etc. having keen interest in the environmental issues. The task of the Committee will be to watch the environment of the district and submit its report time to time. Each member will be paid Rs. 100/- (Rupees one hundred) p.m. for general expenditures incurred by them for visits to the region. Both the Schemes being country wide, are excellent for spreading awareness if practiced properly.

Awareness Through Legal Orders :

Innumerable legal laws have been passed by the government time to time; most of them have been mentioned in the articles contributed in this volume by Dr. Stish Shastri and Dr. Anil Shukla. Above all these, judgement given by honourable justices Ranganath Mishra, G N. Ray and A.S. Anand of the Supreme Court on environmental awareness in the case of Mr. M.C. Mehta Vs Union of India and others is worth mentioning. The honourable judges referred Article 51 A cl(g) from the Constitution of India stating the duty of each citizen of India "to protect and improve the natural environment including forests, lakes, rivers and wild life and to have compassion for living creatures". Following is

the text of the Supreme Court directives to the various organs of the Central and State Governments on the urgent action to be taken by them to create environmental awareness among the people through the various media - (a) All India Radio, Doordarshan, Cinema halls and (b) prescribing courses on Environment for all the students from the primary to University education. The order of the Supreme Court is as under:

"This application is in public interest and has been filed by a practicing advocate of this court who has consistently been taking interest in matters relating to environment and pollution The reliefs claimed in this application under Article 32 of the Constitution are for issuing appropriate directions to cinema exhibition halls to exhibit slides containing information and message on environment free of cost; directions for spread of information relating to environment in national and regional languages and for broedcast thereof on the All India Radio and exposure thereot on the television in regular and short term programmes with a view to educating the people of India about their social obligation in the matter of the upkeep of the environment in proper shepe and making them alive to their obligation not to act es polluting agencies or factors. There is also e prayer thet environment should be made a compulsory subject in schools and colleges in e greded system so that there would be a general growth of awereness. We had issued notice to the Union of India on the petition and the Central Government has immediately responded."

"Until 1972, general awareness of mankind to the importance of environment for well-being of mankind had not been appropriately appreciated, though over the years for more than e century there was a growing realisation that mankind had to live in tune with nature, if life was to be peaceful, happy and satisfied In the name of scientific development, man started distancing himself from Nature and even developed an urge to conquer nature. Our ancestors had known that nature was not subduable and therefore, had made it an obligation for man to surrender to the nature and live in tune with it. Our constitution underwent an amendment in 1976 by incorporating an article (51A) with the heading "Fundamental Duties". Clause (g) thereof requires every citizen to protect and improve the natural environment including forests, lakes, rivers and wildlife, and to have compassion for living creatures. Soon after the international conference on environment, the water pollution control Act of 1974 came on the statute book; the Air

Pollution Control Act came in 1981 and finally came the Environment Protection Act of 1986."

Law is a *regulator of human conduct as the professors* of jurisprudence say, but no law can indeed effectively work unless there is an element of acceptance by the people in society. No law works out smoothly unless the interaction is voluntary. In order that human conduct may be in accordance with the prescription of law it is necessary that there should be appropriate awareness about what the law requires and there is an element of acceptance that the requirement of law is grounded upon a philosophy which should be followed This would be possible only when steps are taken in an adequate measure to make people aware of the indispensable necessity of their conduct being oriented in accordance with the requirements of law.

There has been an explosion of human population over the last 50 years. Life has become competitive. Sense of idealism in the living process has systematically eroded. As a consequence of this, the age old norms of good living are no longer followed. The anxiety to do good to the needy or for the society in general has died out, today oblivious of the repercussions of one's actions on society, everyone is prepared to do whatever is easy and convenient for his own purpose. In this backdrop, if the laws are to be enforced and the malaise of pollution has to be kept under control and the environment has to be protected in an unpolluted state, it is necessary that people are aware of the vice of pollution and its evil consequences.

We are in a democratic polity where dissemination of information is the foundation of the system. Keeping the citizens informed is an obligation of the Government. It is equally the responsibility of society to adequately educate every component of it so that the social level is kept up. We, therefore, accept on principle the prayers made by the petitioner. We are happy to find that the learned Attorney General who appeared for the Union of India has also appreciated the stand of the Petitioner and has even co-operated to work out the procedure by which some of the prayers could be granted.

We dispose of this writ petition with the following directions :

(1) Respondents 1, 2 & 3 shall issue appropriate directions to the State Government and Union Territories to invariably enforce as a *condition of license of all* cinema halls, touring cinemas and video parlours to exhibit free of cost atleast two slides/messages on

environment in each show undertaken by them. The Ministry of Environment should within two months from now come out with appropriate slide material which would be brief but efficiently carry the message home on various aspects of environment and pollution. This material should be circulated directly to the collectors who are the licensing authorities for the cinema exhibition halls under the respective state laws for compliance without any further direction and helping the cinema halls, video parlours to comply with the requirements of our order. Failure to comply our order should be treated as a ground for cancellation of the licence by the appropriate authorities. The material for the slides should be such that it should be impressive, striking and leave an impact on every one who sees the slide.

(2) The Ministry of Information and Broadcasting of the Government of India should without delay start producing information films of short duration as is being done now on various aspects of environment and pollution, bringing out the benefits of society on the environment being protected and the hazards involved in the environment being polluted. Mind catching aspects should be made the central theme of the short films. One such film should be shown, as far as practicable in one show every day by the cinema halls and the central government and the State Government be directed to ensure compliance of this condition from February 1, 1992.

(3) Realising the importance of the matter of environment and the necessity of protecting it in an unpolluted form, we had suggested to learned Attorney General to have a dialogue with the Ministry of Information and Broadcasting as to the manner the All India Radio and Doordarshan can assist this process of education. We are happy to indicate that learned Attorney General has told us that five to seven minutes can be devoted every day and there could be, once a week, a longer programme. We do not want to project an impression that we are authorities on the subjects, but would suggest to the programme controlling authorities of the Doordarshan and the All India Radio to take proper steps to make interesting programmes and broadcast the same on the Radio and exhibit the same on the television. The national network also the State Doordarshan Centres should immediately take steps to implement a direction so that from February 1, 1992, regular compliance can be made.

(4) We accept on principle that through the medium of education *awareness of the environment and its problems related to pollution*

should be taught as a compulsory subject Learned Attorney General pointed out to us that the Central Government associated with education at the higher levels and the University Grants Commission can monitor only the undergraduate and postgraduate studies. He has agreed that the University Grants Commission will take appropriate steps immediately to give effect to what we have said, i e. requiring the Universities to prescribe a course on environment They would consider the feasibility of making this a compulsory subject at every level in college education. So far as education upto the college level is concerned, it would require every state government and every Education upto the matriculation or stage even intermediate colleges to immediately take steps to enforce compulsory education on environment in a graded way. This would be compliance of this requirement.

We have not considered it necessary to hear the Stata Governments and other interested groups as by now there is a general acceptanca throughout the world as so in our country that protection of environment and keeping it free of pollution is an indispensable necessity for life to surviva on earth. If that be the situation, one must turn his immediate attention to the proper care lo sustain environment in a dacent way.

We dispose of the matter with the aforesaid direction but, giva liberty to Shri M.C. Mehta to apply to tha Court from time to time for further directions, if necessary."

To make this order effective, Prof. T. Shivaji Rao of Andhra University, Waltair wrote a letter to our Prime Minister Hon'ble Shri P.V.Narsingha Rao dated 25th February, 1992 requesting to take immediate action. The text of the letter is given below:

1. The Chief Secretaries of the State Governments and Union territories to pass orders directing the Cinema halls, video-parlours to exhibit at least two slides or message on environment in each show, free of cost.
2. The Union Secretary for Environment and Forests to supply the appropriate slides in a different languages for different cinema halls in different states. For this purpose kindly write to the different states with a request to produce such slides on behalf of the Government so that environmental slogans or messages appropriate to reflect the local problems of interest to the common

man can be presented and public cooperation can be enlisted in improving the environment. *

3. The directors of Doordarshan Kendras and All India Radio Kendras and All India Radio Centres in all the States to contact the environmental experts in different localities to prepare environmental messages to be broadcast for 7 minutes every day and to prepare programmes of longer duration to broadcast once in a week to highlight the various crucial problems of ecology and pollution. The University Grants Commission and the Chief Secretaries and Education Ministers of different States took the immediate steps to introduce one compulsory subject on Environment, Pollution and its control in a graded way for all the courses in primary schools, High Schools, Colleges and Universities from the Academic Year 1992-1993."

"Moreover every effort must be made to produce films and video cassettes on various topics in the subjects of Ecology, Pollution, Environmental degradation, Pollution Control technologies, Energy adoptions, Natural resources conservation and sustained development.

Immediate action in this holy task of creating Environmental awareness among the people as envisaged by the Supreme Court judgement will greatly help in the mitigation of human sufferings, environmental degradation and restoration of nature's balances for ensuring a sustained development for a better future of the people of present and future generations."

The spirit of the judgement is that the state must take up the responsibility of not only educating the people about the environment but it is also the responsibility of the system of education to see that the environment is not only conserved but also is improved. For this, courses on environment be offered to right from primary to University levels of education. Such courses must be practical-oriented and fact based so that the students can learn about the environment. After acquiring perfect knowledge the students can apply the same to understand to solve the environmental problems. Prof K S. Chalam[1] has proposed the following scheme:

"Strategy of Implementation

The introduction of environment course as a compulsory paper for B.A., B.Sc., B.Com., B E., M.B B S. and other under graduate courses and the corresponding postgraduate courses needs a systematic

planning. First, it is necessary to establish the strategy through which it can be implemented and, secondly the cost implications in introducing such a course need to be estimated for the guidance of the implementing agency.

Let us first examine the strategy of implementation. An educational strategy is one which requires the augmentation of the existing situation and then doing an exercise in timing. A new course like environment cannot be introduced overnight. It is necessary to undertake a few exercises like holding of seminars/symposia to assess the educational needs and the existing capabilities. It is a known fact that there are very few departments of Environmental Sciences at the University level to prepare the necessary knowledge base for the instructors so that they can in turn train the students. The innumerable activities or activist groups may not help the educational system to impart knowledge, though their presence will certainly help the system to get the necessary practical training in the operation of the abstract concepts taught in the class-room. The first things that need to be taken care of is the preparation of the necessary reading material to suit the content of the syllabi and the standards. After the preparation of the material, the teachers need to be trained or oriented in the content prescribed for the course. An experiment has already been made by the Academic Staff College, Andhra University in organising an inter-disciplinary refresher course in Environmental Science for 4 weeks. The following are the thrust areas in which lecturers working in the disciplines of Zoology, Botany, Geology, Chemistry and Life Sciences are provided with necessary knowledge base in Environment Science and also practical orientation through field work.

1. Ecological Principles
2. Resources and their Depletion
3. Environmental Pollution and Energy Systems, and
4. Environmental Management.

The feedback from the lecturers who attended this course is very encouraging and positive. They have reported that though they knew about certain concepts in environment, the inter-disciplinary exposure in the perspective of an environmental science has widened the scope and depth of their knowledge. It is also felt that they will now be able to make use of their theoretical knowledge to apply in the field to analyse and understand the environmental concerns The course was

organized as an independent programme without considering the introduction of the environmental education at the college and university level. Now it is clear to us that these teachers can definitely handle classes in environment. Therefore, a course structure for training of teachers with cost implications is available on hand for the introduction of the course.

Regarding the preparation of reading material for the course, attempts have already been made by experts like Prof. T. Shivaji Rao, Prof. M.N. Sastry and others of Andhra University to produce textbooks.

Along with the production of reading material, work books in the form of problem solving exercises need to be prepared. Since the course is offered to create knowledge and skills, the experiences gained by extension education can be utilised in the production of reading material. The format of implications, application end skills training of the extension education is provided in the appendix to serve as a model.

Two Alternatives of Implementation

The Implementation of the course at the college and University level follows the immediate next step after training of teachers and preparation of reading material. There are two possibilities of implementation here. One possibility is that of offering the course es a compulsory paper at the First Year in place of any one of the existing courses in Science and Society and/or Indian Culture and Heritage. The syllabi prepared by the experts can be introduced with some modifications that may be deemed necessary. If the course is offered in place of an existing course, there need not be any problem or an additional financial commitment to the government as the work load already exists at the undergraduate level. But, it requires serious consideration for the introduction of the course et the postgraduate level.

The second possibility of introducing the course is through recasting of the syllabi of all subjects in the light of environmental concerns. For instance, a course in history should contain separate chapters or as a part of a unit in a lesson on the historical significance of environment, how human civilisations faced the problem of extinction of certain species due to neglect of environmental concern. Similarly, a course in Chemistry of Zoology should contain aspects relating to environment. It appears that this kind of knowledge base is

more purposeful and practicable in tackling the problems of environment. However, this cannot be done at this stage as the society and the system of education are not prepared to face such a level of advancement at this juncture. But, it can definitely be done in a second phase or a later stage when a climate of environmental concern is created through the first phase, does not require any additional financial commitment as the system will be equipped with the expected changes. Further, the University Grants Commission is launching an experimental programme of vocationalisation of first degree by identifying 35 subjects and a part of t' c content of these courses can be recast in environment at a later stage

New Methods of Instruction

The method of imparting knowledge to the students is also important. As the traditional courses insist on rote memory and are given in the tradition of the banking concept of education in which knowledge is deposited during the instruction and withdrawn at the time of examinations, there is no Praxis according to Paulo Friere. The method of imparting environmental education therefore, is to be different from that of the traditional and established practices. Dialogue is a human phenomenon specific to mankind. 'Love is at the same time the foundation of dialogue and dialogue itself", says Paulo Freire and 'it is thus necessarily the task of responsible subjects and cannot exist in relation of domination. Domination reveals the pathology of love. Sadism in the dominator and masochism is the dominated. Because 'Love is an act of courage, not of fear, love is commitment to other men'. It is the human concern for the fellow human being that is the foundation stone for environmental education. Therefore, interactive methods like dialogue, seminar, project method, etc., need to be insisted upon in imparting knowledge to the students. It is also necessary to insist upon action and practice. But, here there is a danger of repeating action for the sake of action. That is useless for environment. Here action should insist upon change and development. Imparting of environmental with innovative techniques that may come in the process of making it as a mass educational movement.

Cost Implications o the Course

Now the cost implications of the implementation of the course can be looked into. If the course is to be offered as an alternative to the existing one, there is no additional burden on the government or

society at the undergraduate level. But it requires training of teachers in the environmental content. Similarly, additional funds are required to implement the same at the postgraduate level. However, the non-recurring component of the course through the establishment of laboratories, etc. will be minimal as labs do exist in the university system and with some modifications it can be offered at the collegiate level.* Financial implications can be worked out by the respective governments.

APPENDIX

Implications, Applications, placement, Skills and Procedure

Implications Extension education must adequately be linked with regular academic work at the universities/college level. It could find at least three main areas of operation:

1. Placement of extension education in the curricula separately.

2. Treatment of extension duration as a logical outcome of the curricula for its application to societal needs and in making formal educational socielly relevant.

3. Its use in university continuing education curriculum.

Application

I. Extension education is a response to the new dimension of education -traditional and social.

II. Social relevance.

III. Instrument of change plus social welfare concept of education.

IV. Theory plus practice, generation of knowledge, where paucity of knowledge exists.

Placement

1. Extension work should also be treated as curricular activity. It can be treated as a created as a credit course.
2. Additional activity : NSS, NCC.
3. Extension work flows from curricula; it is the application of knowledge: (a) to communicate knowledge, (b) to generate knowledge where gaps exist, (c) to learn from the community, e.g., Chemistry -soil analysis; Biology - plant and living creatures.

The main source of information is oral, to be supported by others at the community level especially in the rural sector and among underprivileged groups.

Skills

1. Observation-cum-participatory skill,
2. Communication skills: (a) Active involvement of the community, (b) Awareness of needs, problems, aspirations of people, (c) Exchange of ideas, personal contact group, discussions, administrations, etc. (d) Ability to record information, (e) Ability to analyse and disseminate.
3. Problem Solving.

Procedure Participatory – organisation of village committees – problems, inputs, appraisal of value system.

Group Involvement; Some Examples

- Women, rural and slum areas
- Scheduled castes and scheduled tribes
- School dropouts
- Unemployed youth with some schooling
- Unemployed youth without some schooling
- handicapped
- Workers in Unorganised sectors
- Workers in the organised sectors
- Teachers - Primary, Secondary and handicapped
- University/college students from underprivileged rural/slum groups
- Other organisations in the community like cooperative society panchayat, council, etc.
- New action groups to be organised from the community to tackle problems faced by various sections of society."

On the same lines the courses can be framed for primary, middle, secondary and higher secondary levels as per standard of the class.

Tours, excursions camps be kept compulsory so that surrounding areas can be visited regularly. The NSS, NCC, Scouting, etc. must be

environmental improvement task oriented. It will spread the awareness fast and cultivate the environment love among the students."

The Courses initiated by the UGC

The University Grants Commission is encouraging to run the various courses on the environmental aspects. A course contents based on UGC guide-lines for Undergraduate has been planned as under[2];

ENVIRONMENT AND WATER MANAGEMENT FIRST YEAR TDC ARTS

Fundamentals of Environmental Science -I The need for the study of environment. Definition, Scope, and of approaches of various facets of environmental sciences. Elements of environment and their characteristics. Introduction of ecosystem, food-chain and food-web and ecological pyramids. Abiotic and biotic components of ecosystem - autotrophic and Hetero-trophic components.

Environment and its Pollution - I Definition and kinds of environmental pollutions, causes and symptoms of air and water pollutions. Impact of air and water pollution on biota. Soil pollution, noise and thermal pollution due to radio- activity

Laboratory (Practical) Maintaining an experimental eco-system such as, aquarium and understanding basic principles of eco-system.

- Measuring selected abiotic (temperature, turbidity, free carbon - dioxide, pH, Conductivity/total dissolved solids) factors.
- Soil testing for certain physico - chemical properties (pH, Phosphates, etc).

Fundamentals of Environmental Sciences -II Dynamics of ecosystem: energy flow in ecosystems, Biochemical cycles (Carbon, Phosphorus and Nitrogen cycles). Introduction to different types of ecosystems (Freshwater, marine and terrestrial). Applied ecology: definition and scope, conservation of natural resources, waste recycling and use of renewable energy source. Environmental laws related to air and water.

Environment and its Pollution - II Types of Pollution - Pollutants and their sources. Air Pollution, Water pollution, soil pollution, soil pollution, Noise pollution, Biotic Pollution, land pollution.

Global environmental problems such as - Green house effect, depletion of ozone layer. Public health and environmental pollution. Anti-pollution measures. Ecology of air and water pollution. Bio-degradable and non-biodegradable pollutants Pollution problem due to domestic sewage and certain other organic wastes and industrial effluents.

Laboratory (Practical)

- Identification of selected freshwater, marine and terrestrial animals.
- Identification of selected freshwater plants

On the Job Training - I (Summer one month) Measuring various types of environmental factors in the specific field, survey of environmentally sick areas for water/soil/noise pollutions.

SECOND YEAR TDC ARTS WATER RESOURCE MANAGEMENT - I

Introduction to various kinds of water resources and their uses: standing and running water systems, ground water resources. Elements of management for surface and ground water resources. Integrated water management (Water-shed system management for various purposes (e g. Fisheries, Dairy, horticulture and agriculture).

WATER QUALITY MANAGEMENT : I Water quality and human health. Basics of water quality, criteria of water quality for various uses, water quality standards, general methods for assessing water quality, specific water quality problems and solutions, methods for treatment of drinking water. Ganga Action plan. Water quality: selected issues in urban and rural areas. Quality problems and measures for ground water management. Study of River and Lakes and other waterbodies of surrounding area.

WORK PRACTICE (PRACTICAL) Observations of Municipal water supply schemes and filter plants. Assessing selected water quality parameters Treating water at domestic level. Observations of water shed programme of any region.

WATER RESOURCE MANAGEMENT - II Measures for managing water-shed system. Management strategies for water resources used for drinking, irrigation and industries. Bio-manipulation and eco-tech-

nology measures or management. Conservation of wetlands and their utility, management of waters in dracunculiasis and fluorosis affected areas. Managing general environment for water resource management.

WATER QUALITY MANAGEMENT - II Bacteriology of sewage, sewage treatment using oxidation ponds. Use of traditional methods for purifying drinking water. Use of UV radiation and various chemical for disinfecting water, desalinization and defluo-radiation techniques.

WORK PRACTICE (PRACTICAL) Use of different chemicals for disinfecting water, Observations of slides of algae and bacteria of water. Observing sewage or such organic waste/effluent treatment plant and preparing the record work on the basis of that field observation.

ON THE JOB TRAINING (Summer - One Month) Survey of effluent treatment plant. Study of any water-shed system or water quality related programme and its impact on the community.

FINAL YEAR TDC ARTS

ENVIRONMENTAL MANAGEMENT - I & II

I. Basics of environmental management; characterization of Urban and rural environment; problems and remedial measures for solid waste disposal; an environmental impact assessment for environmental planning; Industries and environmental Health Management.

II. Managing Landuse and green belts; Traffic and Associated problems and their solutions; Managing hazardous waste; Management of forest eco-systems and grass lands; concept of community forest; management of mining activities Management of coastal waters.

PROJECT DEVELOPMENT: Suitable project may be developed on any of the environmental issues stated above for rural and urban areas. Working out cost benefit of environmental management programmes on specific issues.

WORK PRACTICE - I & II

I. Working out models for any type of environmental management issue; observation on occupational healthy impact of industries on surrounding environment.

II. Studying works of community forest and mining activities; practice in identification of plants, herbs, and ores of areas.

PROJECT WORK:

A specific environment related problem may be assigned for detailed study using appropriate methodology. A final report of about 50 typed pages may be submitted. This work will be performed in a penod of 6 months.

LIST OF REQUIRED EQUIPMENTS

S No.	Name	Approx. Cost in Rs.
1.	PH meter	5,000 00
2.	Conductivity meter	6,000 00
3.	Turbidity meter	5,000 00
4.	Soil Testing Meter	3,000.00
5.	Water Testing kit	20,000 00
6.	Water Samplers	5,000.00
7	Smoke meter	5,000.00
8.	Microscope (Simple & Binocular)	10,000.00
9.	Oven	5,000 00
10.	Microbalance (Menopan)	20,000.00
11.	Xerox Machine	1,50,000 00
12.	Overhead projector	8000 00 (Approx.)
13.	Slide projector	7000 00 (Approx.)
14.	Field Camera	10,000 (Approx.)
15.	Oxygen Meter	7,00 00
16.	Distillation Apparatus	5,000 00
17.	Typing Machin English	20,000 00
18.	Typing Machin Hindi	10,000 00
19.	Noise Measuring Apparatus	20,000.00
20.	PC AT (386 Sx) with printer	1,00,000 00
21	Furnishing & Assessories	1,00,000 00
	Total	3,97,000 00

OTHER REQUIREMENTS

S. No	Name	Approx. Cost
1.	Space-Laboratory -1 (600 Sq feet)	1,20,000.00
	Classroom -1 (600 sq feet) @ Rs 200/ per sq. feet	1,20,000 00
2.	Equipments- A Separate list is enclosed	
3.	Books - Approx	50,000.00
4.	Faculty members required -2 posts	To be added
5.	Additional Posts -2 i) Lab Assistant -1 ii) Lab Boy -1	
6.	Guest Faculty - 15 Lectures	
7.	Audio- visual Aids' - OHP Sheets, colours, photos, slides & Transparencies etc.	3,000 00
8.	Transportation (field survey).	20,000 00
9.	Consumables	50,000 00
10.	contingency	48,000 00
11.	Miscellaneous expenditure	5,000.00

UGC has also framed its own course which will be run in the selected colleges and universities all over the country w.e.f. 1994 session.

SCHOOL OF ENVIRONMENTAL SCIENCES

As education is the most powerful instrument to bring about change in attitude and behaviour, the awareness must be cultivated through it. But it is a huge task to educate millions of students on environmental aspects. To cope with this huge task a large number of trained teachers, administrative personnel and well managed programmes are urgently needed. At present there is a serious shortage of trained personnel as well planned programmes. Universities which possess a variety of resources at hand, are in an especially unique position to play an important role in the development and implementation of the inter-disciplinary subject of environment of education.

OBJECTIVES

1. To assist academic institutions in planning and developing environment education programmes.
2. To conduct training programmes for various categories of personnel.
3. To provide community-out-reach programmes and services by faculty and students through extension departments.
4. To encourage faculty and students to undertake research and evaluation studies.
5. To undertake production of instructional materials and audio-visual aids.
6. To undertake promotional activities through publication of News letters, Magazines, Journals, etc. and through institutional contacts.
7. To provide consultation services to the local, state and national governments in programme planning and development.

It is suggested that the University may consider offering Environment Studies and Education as:

(e) Foundation Course for all Undergraduate degree students.

(b) Elective Course at the Undergraduate degree level.

(c) Specialised topics be included in certain relevant subjects such as sociology, Economics, Political Science, Geography, Psychology and relevant papers of science and commerce.

(d) Environment concepts integrated at appropriate points in professional courses.

ROLE OF THE SCHOOL OF ENVIRONMENT

1. To provide consultative services in developing curriculum and instructional materials for the courses in environment studies and education at the Undergraduate degree level.

   The staff and members of the Department of Environment may act as Members of the curriculum Committee on invitation by the University.

2. To provide consultative services in planning and developing programmes.

To assist in the preparation and evaluation of curriculum and instructional materials, teacher's guide books, learning kits and audio-visual aids for collegiate and out-of-college youth programmes.

3. To conduct workshops, seminars and Training programmes.
4. To assist in the production of training materials and in conducting training programmes for administrators and others.
5. To provide consultation for conducting basic research relating to knowledge base for developing curriculum and instructional materials.
6. To provide bibliographies and guides, selective dissemination of information, review of the literature, repackaged information etc.
7. To collect and reproduce relevant and useful curriculum end instructional materials produced by other organisation within India and other countries and supply them along with the materials produced by the Department of Environment to the School of environmental sciences of the University.
8. To assist in developing library, documentation and information services by providing technical assistance in the form of consultation, and such follow-up assistence as exchange of ecquisitions and cataloguing information.

COMMUNITY CENTERED AWARENESS THROUGH ENVIRONMENT IMPROVEMENT TRUST

To cultivate the awareness society as a whole has to be made the target while developing the close relationship among ENVIRONMENT, EDUCATION AND SOCIETY. On the basis of age, occupation, religion, education, etc. various groups should be formed for likemindedness. Environment and Education are two very important wheels on which the society can be run smoothly (Fig. 1). This must be an autonomous organisation and be named as "ENVIRONMENT IMPROVEMENT TRUST".

As a matter of fact, the establishment of Environment Improvement Trust has been suggested with the aim to make the people aware about the environmental problems, their effect on the individual, his family community, society, settlement, the nation and the world. It also aims to develop attitude and understanding to help human beings to make rational and responsible behaviour towards environmental

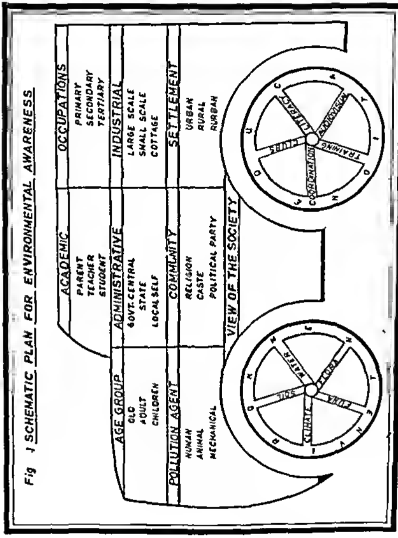

Fig 1 SCHEMATIC PLAN FOR ENVIRONMENTAL AWARENESS

matters. This programme will be very useful to generate the momentum of accepting improvement and awareness methods at a faster speed and will have determined and effective attack on the agents of environmental degradation.

STRATEGY

The aim of the project is to improve the quality of environment by cultivating awareness in the society. This idea belongs to environmental development which leads to society welfare.

The management of natural resources is directly the responsibility of the State Government. The Government has to save and protect the natural resources while fulfilling the needs of the public. Public, while fulfilling her needs overexploits the resources unmindfully. Thus, the prime duty is to create the awareness of Environmental Conservation at all the levels, i.e. Government (Central, State and local self) and public both . The central Government must provide financial assistance to state government. After adding some more funds it must solve the problems immediately by providing the technical expertise and know how. Such problems should be supervised by trained personnel Invariably.

A detailed guideline be prepared by the state government covering all aspects of the Environmental problems and their management. This also needs close and effective monitoring and supervision. In this connection, the state government has to alert its own departments of Industry, agriculture, law, land allotment, forest, mining, PHED, Industrial, etc.

Education causes a change in the environment. The introduction of environmental education will cause a change in the society and the society will naturally affect the use of environment. By extending the knowledge of environment explaining the cause and effect of different types of pollution to the society, an awareness about the conservation will definitely be cultivated. Through the education, the society will realise the fact and will stop the careless exploitation of the environmental resources. By stopping deforestation and adopting afforestation two way advantage will be enjoyed checking of soil erosion and increasing the amount of oxygen in the atmosphere, besides the other gains to the ecosystems. Thus, environment, education and society are very closely interrelated and any disturbance in their relations will cause a great harm to the society. For this the "*Feed back Loop Structuring*" must be adopted.

GAP

A gap is the difference between actual and standards. In other words, it is the difference between what it is at present and what is should be. At present the environmental deterioration is at a faster rate, giving rise to innumerable problems, hereby lowering down the standard of living.

Through the Trust environmental conservation awareness can be cultivated and the degradation problem may be minimized, rather it can be eradicated; reducing the existing enormous gap to zero or near zero. When the gap is brought to nil, the standard is maintained fully as desired and environmental quality is there. This situation presents a balanced ecological adjustment of the society.

LEGAL PROTECTION

While carrying out the project certain suggestions can be sorted out which must be given a legal shape to stop and avoid further deterioration of the ecosystem. In this regard, special recommendations can be made for forest protection, open air latrines, flow-direction of sanitary pipes, dirt-dumping ground, potable water, dead animals, industrial establishment, waste disposal, mining lease, allotment of *residential plots, green belts, etc.*

Innumerable rules as described earlier are already existing but are not being practiced properly. Such rules can be brought to the notice of the public in the context of their welfare. A few areas can be suggested which need legal protection

PEOPLE'S PARTICIPATION

The main aim of this project is to create the environmental conservation awareness while associating local public to the maximum extent. This approach becomes all the more important when the public has to face certain restrictions for the improvement of the environment to lead a better life. The individual commits many mistakes thinking that this is not going to harm him. People cut the forest unmindfully, pollute the water carelessly and so on. With the help of legal provisions, personal awareness can also be cultivated leading to the societal development. people can be made to understand and to realise the merits of the programme so that they become the custodians of the environment. Innumerable researches conducted by the Department of Environment and other agencies

which throw light on the various environmental aspects, need dissemination as these will help in environment building for the Trust.

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STRATEGIES FOR SUSTAINABLE INDUSTRIALISATION

RAJIV K. SINHA

Industrialisation is a "necessary evil" and the modern human civilisation also cannot do without it. Hence we have to plan strategies of Industrial development with minimum destruction:

1. REPLACEMENT OF COAL BY NATURAL GAS AS A SOURCE OF ENERGY FOR MAJOR INDUSTRIES

Coal-based industries are worst polluters as the coal contains nearly 20-40% ash and about 2% sulphur. Coal accounts for nearly 65% of energy source for industries in India. Natural gas is a better source of energy, with 80-90% methane content. It has higher thermal efficiency and environmentally much safer because it neither gives fly-ash nor that amount of sulphur dioxide. India produces 45 million cubic metres of NG/day and has a potential of 100 m cum/day. All the industries (both goods and energy generating) located in the western part of India can be fed by natural gas. Advancement in pipeline technology and development of liquefaction process have made natural gas more convenient and transportable. The HBJ (Hazira-Bijapur-Jagdishpur) gas pipeline terminating in U.P. can be extended upto Bokaro in Bihar, Durgapur in West Bengal and Rourkela in Orissa.

Hydrogen gas will, however, emerge as the safest and cleanest energy source for industries in future when their commercial production becomes technologically feasible. It releases more heat in combustion with minimum toxic emission.

Table 1: Thermal efficiency and emission characteristics of various *energy sources for the industries*

Fuel	Emission products	Heat of combustion
1. Coal	CO, CO_2, SO_2, NO_2, Fly ash	7 8 Kcal/gm
2. Petrol	Co, CO_2, NO_2, SO_2	8.4-10 3 Kcal/gm
3. Natural gas	CO_2, NO_2, Trace of SO_2	11 0-12.5 Kcal/gm
4. Hydrogen	Water, NO_2	34 0 Kcal/gm

2. ECOLOGICAL MANAGEMENT OF INDUSTRIAL WASTES

The industrial wastes- gaseous, solid and liquid are the main sources of environmental problems and there is great wisdom in their ecological management based on the principle of three Rs r.o reduction, reutilisation and recycling. It saves energy and expensive raw materials; protects the environment, and cuts the cost and risk of treating, storing, transporting and disposing of wastes.

Waste generation can be minimised by changing the manufactur*ing process; separating and concentrating the wastes; using different* raw materials and replacing hazardous products with safer substitutes. There is great potential for recovering several materials like paper, plastics, rubber, solvents, glass and metals from the solid and liquid industrial wastes. Even the gaseous wastes like sulphur dioxides and nitrogen oxides could be converted into sulphuric and nitric acids respectively. UNEP sponsored "Cairo Guidelines and Principles for the Environmentally Sound Management of Hazardous Industrial Wastes" were issued in 1985. Japan, U.S. and other West European countries are working on the principle of "Waste Exchange". One industry's waste is being reutilised as other's raw material.

Underground storage of hazardous wastes in safe beds and abandoned mines is another safe strategy to get rid of the problems. U.S., Canada, Germany, the Netherlands and Denmark are practicing this strategy. In Germany nearly 270,000 tonnes of hazardous wastes have been dumped about 700 metre down in abandoned potash mines since 1972. Annual storage potential is now from 35,000 to 40,000 tonnes.

Incineration system if properly designed can provide the highest degree of destruction and control for the broadest range of hazardous wastes with tremendous recovery of heat energy for other industrial needs. U.S., Denmark, Finland, Sweden, South Korea and Germany are having this facility but with the present technology it is not entirely safe for the environment.

3. COMPULSORY RECYCLING OF ESSENTIAL MATERIALS OF MASS CONSUMPTION

Iron, aluminum, and glass are materials of mass consumption for our civilisation which consume tremendous energy and cause blatant *environmental destruction when processed from their ores*. The environment has suffered immensely because of ore based metallurgical *industries both in the pre- as well as the in the post-industrial* development starting from deforestation, mining, water and energy consumption to the problems of air, water, noise pollution and solid waste generation.

World steel production alone consumes as much energy annually and Saudi Arabia produces. Using coke for iron ore reduction produces copious particulates including carcinogenic benzopyrene. Recycling of iron reduces this emission by 11 kg/metric tonnes of steel produced. It also cuts iron ore and coal mining wastes by 11,000 kg/metric ton recycled.

Recycling aluminum would eliminate over a million tons of air pollutants including toxic fluoride. Japan, Italy and Germany are recycling aluminum on a large scale.

Paper products use about 35% of the world's annual commercial wood and it is likely to grow upto 50% by 2000 A.D. Paper recycling would help in conserving the forests. For every ton of paper produced roughly 17 trees are sacrificed. Japan, the Netherlands, Mexico, South Korea and Portugal lead in waste paper recycling. Roughly for every 1 kg of recycled paper 1.3 kg of waste paper is required. In India recycling of waste paper is being made to obtain hard cardboard paper for packing materials. It also utilises wastes cotton and jute material for *production of paper for stationery uses.*

Environmental benefits derived in terms of energy savings, water consumption, solid waste reduction, pollution control and conservation of forest in case of recycling of iron and steel, aluminum, paper and glass are given in Table 2.

Table 2 : Environmental benefits of recycling

Materials recycled	Energy savings	Pollution control	Reduction in solid waste	Water saving	Protection of forest
1. Iron and steel	60-70%	30%	95%	40%	100%
2. Aluminum	90-95%	95%	100%	46%	100%
3. Paper	30-55%	95%	130%	58%	100%
4. Glass	32%	20%	60%	50%	•

Source : State of the World, 1984 (World Watch Institute Report, Washing-ton)

Similar environmental benefits can be obtained in the recycling of other metals like copper, chromium and mercury.

4. "LOW-WASTE" OR "NO-WASTE" SUSTAINABLE INDUSTRIAL TECHNOLOGY

There is urgent need for innovation of "low-waste" or "no-waste" environmentally clean, non-polluting and less energy intensive technologies for industrial development. The UNEP office for industry and environment has made publications of environmentally sound technologies for specific industries. It emphasises on recycling *technologies, alternative methods of production* and safer substitutes for certain industrial raw materials.

The emergence of new technologies is one of the most important recent trends in industrial development. Robotics, automation, micro-electronics, information technology, biotechnology and discovery of new materials promises for modernisation of production process in traditional industries with better efficiency and very low waste discharge. Advances in biotechnology promise safe treatment of toxic industrial wastes through genetically tailored bacteria. Development of microelectronics would promote "in-plant" recycling of waste streams and significantly reduce production losses.

Properly guided technology through microelectronics and improved communication system can transform patterns of industrialisation. It would lead to geographically better dispersal of industries; avoid their excessive concentration in the urban areas; and spread them to even remote rural areas. This is very important because even if all industries in a given area follow regulations and emit toxic gases within prescribed limits, the cumulative effect of all the industries on

the environment of that area would be disastrous. Development of computerized "environmental sensors" has made it easier to monitor industrial emissions in and around factories and hence has minimised the risk of accidents and have provided better protection to both man and the environment.

Gandhian Ideology and Sustainable Industrialisation

Gandhi was against heavy industrialisation of India in the manner of the West. It has led neither to efficient utilisation of scarce resources, nor to a more equitable distribution of the products. Gandhi believed in "production by the masses" and not "mass production". Mass production by individuals leads to concentration of wealth in one hand and exploitation of both the native and the nature. He wanted cottage industries in every home of India.

As early es 1927 Gandhi hed forewarned the world that large scale *industrialism would create problems of the type we are confronting* today. He wes, however, not against industrialisation, but much against "industrielism" end the "dehumanized machine culture". He wanted labour participation in management and pleaded with the Industrialist to become "trustees" of the welfare of the both the native and nature by behaving as their "partners" in progress end not as their "masters" for exploiting them.

Cultural and Behavioural Changes in Demand : The Lasting Solution

At the root of the problem lies the "over-consumerism" culture of the modern civilization and is directly related to extravagant life style. Material wants have been growing enormously and in order to satisfy the ever-increasing demands of more "comforts" and more 'luxury" in life mankind have been indiscriminately exploiting the natural resources for rapid industrialisation disregarding their environmental consequences.

Now, that the human civilisation has realised that this Industrial society is no longer sustainable, we have to take important decisions which concern our very survival on earth. Environmental ethics of our survival demands that we have to mend our ways; change our behaviour and attitude of life; cut our demands; reorder our priorities; simplify our life style; give up consumerism culture; consume judiciously according to need, and live in harmony with nature. I am still not convinced whether mankind really needs all those chemical

and hazardous industries-the potential "time bombs", for their dignified living with comforts but of course not with luxury.

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